IN THE UTAH SUPREME COURT

CASTLE VALLEY SPECIAL SERVICE DISTRICT, NORTH EMERY WATER USERS' ASSOCIATION, and HUNTINGTON-CLEVELAND IRRIGATION COMPANY, Petitioners, vs. UTAH BOARD OF OIL, GAS AND MINING, Respondent.	**APPENDICES TO BRIEF OF INTERVENOR**
C.W. MINING COMPANY d/b/a CO-OP MINING COMPANY, Intervenor.	Case No. 950487 Cause No. ACT/015/025-93B Docket No. 94-027 Priority No. 14

PETITION FOR REVIEW OF ORDER OF THE UTAH BOARD OF OIL, GAS AND MINING

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APPENDICES TO BRIEF OF INTERVENOR

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FILED
OCT 2 0 1994
SECRETARY, BOARD OF
OIL, GAS & MINING

APPENDIX 7-J

PROBABLE HYDROLOGIC CONSEQUENCES OF MINING AT BEAR CANYON MINE, EMERY COUNTY, UTAH

CO-OP MINING COMPANY
Bear Canyon Mine
Emery County, Utah

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PROBABLE HYDROLOGIC CONSEQUENCES OF MINING AT BEAR CANYON MINE EMERY COUNTY, UTAH

1.0 INTRODUCTION

The purpose of this document is to present an assessment of the probable hydrologic consequences of operating and reclaiming Bear Canyon Mine. Where possible, the impacts from potential future expansions will be addressed. Although data collected from the expansion areas are included in this document, it is recognized that baseline water monitoring requirements for proposed Federal Lease expansion areas have not been satisfied as of the date this document was submitted. When baseline monitoring in the proposed expansion areas is complete, this document will be revised and re-submitted.

This document is divided into five sections, including this introduction. Section 2.0 presents probable groundwater impacts and groundwater monitoring plans. A similar discussion of surface water impacts and monitoring is provided in Section 3.0. Conclusions and references are listed in Sections 4.0 and 5.0, respectively.

2.0 GROUNDWATER

2.1 BACKGROUND INFORMATION

Detailed information on groundwater and the physical resources that effect groundwater in the permit and adjacent areas is found in Chapters 6 and 7 of the M&RP and the Revised Hydrogeologic Evaluation of the Bear Canyon Mine Permit and Proposed Expansion Areas, (EarthFax Engineering, 1992). This information is summarized herein for convenience.

2.1.1 Climatology

The Bear Canyon Mine is located in an area of semiarid to subhumid climate (Danielson, 1981). According to the monthly climatological data collected by the Utah Climate Center (Table 2-1), temperatures at the Hiawatha Station have an average range during the period of record (1989 through 1991) from 7.5° to 70° F.

A new rain gauge was installed at the Bear Canyon Mine in August 1991 by Co-Op Mining Company (Table 2-2). Average precipitation measured at the Bear Canyon Mine station is 0.89 inches per month for the period from August 1991 to May 1992. Monthly average precipitation has ranged from 0.04 to 2.65 inches per month.

Wind velocities recorded at the nearby Huntington Research Farm are typically less than 15 mph, for years 1990 and 1991 (Table 2-3). Average wind velocities are estimated at 10 mph near the Bear Canyon portal area (Chapter 11, M&RP). Wind directions are generally controlled by the orientation of the canyons. The prevailing wind direction in the area of the Bear Canyon portal is west-southwest (Chapter 11, M&RP).

TABLE 2-1

Monthly Temperatures
Measured at the Hiawatha Station [a]

	January	February	March	April	May	June	July	August	September	October	November	December
1989	19.5	23.4	38.5	47.9	51.9	58.8	70.0	62.8	(M)	45.8	36.9	28.8
1990	23.2	26.7	37.5	46.1	50.5	63.3 [I]	67.3	65.40	60.5	45.5	7.5	16.9
1991	20.0	32.6	29.6	39.0	49.2	59.7	67.5	64.5	57.2	48.3	30.9	23.6
Avg	20.9	27.6	35.2	44.3	50.5	60.6	68.3	64.2	58.9	46.5	25.1	23.1

[a] Utah Climate Center (1992).
[I] Indicates 1 to 9 days of data are missing; a monthly value was calculated from available data.
(M) Indicates 10 or more days of data are missing; no monthly value was calculated.

TABLE 2-2

Bear Canyon Mine Precipitation Data

MONTH/YEAR	MONTHLY TOTAL (inches)	DAILY MAXIMUM (inches)	DAILY MINIMUM (inches)
Aug. 1991*	0.82	0.18	0.00
Sept. 1991	2.65	0.98	0.00
Oct. 1991	0.74	0.46	0.00
Nov. 1991	0.85	0.24	0.00
Dec. 1991	0.14	0.04	0.00
Jan. 1992	0.28	0.06	0.00
Feb. 1992	0.07	0.04	0.00
Mar. 1992	0.71	0.27	0.00
Apr. 1992	0.34	0.33	0.00
May 1992	2.25	0.67	0.00

* The installation date of reading gauge was in the month of August. The initial gauge reading was taken on Aug. 14, 1991.

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TABLE 2-3

Huntington Research Farm Wind Data[a]

Date	Average mph	Maximum mph	Minimum mph	V-Direction[b] degree
March 1990	6.9 (m)	10.0 (m)	3.6 (m)	228 (m)
April	9.4	14.3	6.1	230
May	8.7	12.5	6.0	237
June	10.1	12.3	7.4	219
July	9.8 (m)	11.9 (m)	8.4 (m)	232 (m)
August	9.8	12.7	4.9	236
September	10.5 (m)	13.0 (m)	6.4 (m)	218 (m)
October	8.5	12.8	5.7	242
November	8.6 (m)	13.9 (m)	4.3 (m)	233 (m)
December	-	-	-	-
January 1991	5.7 (m)	11.6 (m)	1.9 (m)	237 (m)
February	8.3 (m)	9.1 (m)	7.6 (m)	311 (m)
March	7.7	11.7	3.0	299
April	10.2	14.2	6.5	316
May	9.5	15.7	5.9	309
June	9.4	12.0	5.2	301 (m)
July	9.6	12.9	6.5	301 (m)
August	9.9	13.0	6.9	308
September	9.5	12.7	3.0	307
October	9.5	14.7	4.0	307

(a) Utah Climate Center (1992).
(b) Azimuthal direction of wind .
(m) Indicates ten or more days of data are missing for the month.

TABLE 2-3 (Continued)

Huntington Research Farm Wind Data[a]

Date	Average mph	Maximum mph	Minimum mph	V-Direction[b] degree
November	6.8	14.4	3.0	285
December	5.8	12.3	2.3	247
January 1992	6.9	17.6	2.4	261
February	7.2	14.0	1.6	300
March	8.8	16.2	4.3	332

(a) Utah Climate Center (1992).
(b) Azimuthal direction of wind.

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2.1.2 Hydrogeology

The North Horn Formation, Price River Formation, Castlegate Sandstone, Blackhawk Formation, Star Point Sandstone, and Mancos Shale outcrop in the permit area. The stratigraphic sequence reflects an oscillating, yet overall regressive depositional environment. This changing environment resulted in great thicknesses of discontinuous sandstone, coal, and mud/siltstone units. Table 2-4 presents the stratigraphic relationships and surface water yield of these geologic units.

The main coal-bearing strata in the Wasatch Plateau is the Blackhawk Formation. The Trail Canyon and the Bear Canyon mines produce coal from the upper Blind Canyon Seam and the lower Hiawatha Seam (EarthFax Engineering, 1992, p. 2-4). Co-Op Mining Company proposes to begin mining the Tank Seam (approximately 220 to 250 feet above the Blind Canyon Seam) in 1994. Regionally, the strata in the study area dip to the south and southeast at an angle of two to three degrees (Brown, et al., 1987); this dip direction was confirmed by the stratigraphy observed during in-mine drilling conducted in 1992, although dip angles determined from in-mine drilling ranged from 0.44 to 1.47 degrees. The Bear Canyon and Trail Canyon mines are located in a complex graben bounded by the Pleasant Valley Fault (on the west) and the Bear Canyon Fault (on the east), (Plate 1, EarthFax Engineering, 1992). Vertical displacements on both faults are approximately 100-150 feet. Brown, et al. (1987) describe a shattered zone within the graben, approximately two miles north of the current northernmost extent of the Bear Canyon Mine. In the portion of the graben within the permit area, only minor faults (vertical displacements of 20 feet or less) have been identified, with the exception of the Blind Canyon fault (Plate 1, EarthFax Engineering, 1992), which is estimated to have approximately 220 feet of vertical displacement (down to the west) in the vicinity of the Bear Canyon Mine (M&RP).

The Castlegate and the Star Point Sandstones are regionally continuous. Although the Castlegate Sandstone contains some water (Danielson, 1981), it is not considered to be a regional aquifer. The Star Point Sandstone together with the lower Blackhawk Formation

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TABLE 2-4

Stratigraphic relationships, thicknesses, lithologies, and water-bearing characteristics of geologic units in the upper drainages of Huntington and Cottonwood Creeks (adapted from Stokes, 1964)

System	Series	Formations and members	Thickness (feet)	Lithology and water-bearing characteristics
Quaternary	Holocene and Pleistocene		0-100	Alluvium and colluvium; clay, silt, sand, gravel, and boulders; yields water to springs that may cease to flow in late summer.
Tertiary	Eocene and Paleocene	Flagstaff Limestone	10-300	Light-gray, dense, cherty, lacustrine limestone with some interbedded thin gray and green-gray shale; light-red or pink calcareous siltstone at base in some places; yields water to springs in upland areas. (See table 9.)
	Paleocene	North Horn Formation.	800±	Variegated shale and mudstone with interbeds of tan-to-gray sandstone; all of fluvial and lacustrine origin; yields water to springs. (See table 9.)
Cretaceous	Upper Cretaceous	Price River Formation	600-700	Gray-to-brown, fine-to-coarse, and conglomeratic fluvial sandstone with thin beds of gray shale; yields water to springs locally.
		Castlegate Sandstone	150-250	Tan-to-brown fluvial sandstone and conglomerate; forms cliffs in most exposures; yields water to springs locally.
		Blackhawk Formation	600-700	Tan-to-gray discontinuous sandstone and gray carbonaceous shales with coal beds; all of marginal marine and paludal origin; locally scour-and-fill deposits of fluvial sandstone within less permeable sediments; yields water to springs and coal mines, mainly where fractured or jointed.
		Star Point Sandstone	350-450	Light-gray, white, massive, and thin-bedded sandstone, grading downward from a massive cliff-forming unit at the top to thin interbedded sandstone and shale at the base; all of marginal marine and marine origin; yields water to springs and mines where fractured and jointed.
		Mancos Shale	600-800	Dark-gray marine shale with thin, discontinuous layers of gray limestone and sandstone; yields water to springs locally.

(Blackhawk-Star Point aquifer) are considered by Lines (1981) to be a regional aquifer. However, evidence from recent drilling and testing of the Star Point Sandstone indicates that the regional aquifer lies below the Star Point/Mancos Shale contact (EarthFax Engineering, 1992, p. 2-13). Additionally, separate and distinct aquifers were defined in the Spring Canyon, Storrs, and Panther tongues of the Star Point Sandstone (EarthFax Engineering, 1992, pp. 2-21 and 2-22). Other groundwater occurring above the Star Point aquifers is contained in perched, discontinuous aquifers in the upper Blackhawk Formation, the Castlegate Sandstone, the Price River Formation, and the North Horn Formation (EarthFax Engineering, 1992, p. 2-11).

Data collected from pumping tests and core analyses from the Trail Mountain area (approximately 10 miles south-southwest of the Bear Canyon Mine) indicate that the transmissivity of the full thickness of the Blackhawk-Star Point aquifer probably ranges from about 20 to 200 ft^2/day (Lines, 1985). Slug tests performed on the three tongues of the Star Point Sandstone (Spring Canyon, Storrs, and Panther) within the permit area yielded transmissivities ranging from 1 to over 50 ft^2/day (EarthFax Engineering, 1992, Table 4-2, p. 4-8).

Average linear velocities of groundwater in the three Star Point Sandstone aquifers were calculated using slug test data (EarthFax Engineering, 1992, Table 4-2, p. 4-8) and ranged from 0.0036 to 0.191 feet per day. These velocities indicate that groundwater beneath the Bear Canyon Mine moves to the south and southeast at between 1.31 and 69.72 feet per year.

Outcrops within the permit area include the Price River Formation, Castlegate Sandstone, Blackhawk Formation, Star Point Sandstone, and the Mancos Shale. Danielson, et al. (1981) indicate that recharge to the Star Point-Blackhawk aquifer from direct infiltration of snowmelt to formations which outcrop below the North Horn Formation is small in comparison to recharge through low relief surfaces on the North Horn Formation. In the study area, exposures of formations below the North Horn Formation and above the coal outcrops are limited to steep canyons. Therefore, the potential for recharge through these formations to the regional groundwater system within the permit area is limited. Within the proposed expansion area, there are three springs associated with the perched aquifers above the coals mined by Co-Op Mining Company. No springs were found within the present permit area. A number of low volume springs (2 gpm or less) occur north of the permit area and issue from the perched aquifers lying above the coals (Appendix 7-M, M&RP). All other springs in the permit and adjacent areas discharge from the Star Point Sandstone or from colluvial slopes which cover the Star Point Sandstone. The two largest springs in the area (Big Bear Springs and Birch Springs) are associated with fault and joint zones and issue from the Panther Tongue of the Star Point Sandstone (Chapter 7, M&RP and EarthFax Engineering, 1992, pp. 2-14 and 2-17). These two springs have been developed and are used by the Huntington-Cleveland Irrigation Company and the North Emery Water Users Association for culinary purposes.

Table 2-5 presents flow rates measured during the initial sampling of each spring and mine water monitoring point. Locations of these monitoring points are presented on Plate 7-4 of this M&RP. Average flow rates measured at Co-Op Mining monitoring points in 1991 are presented in Table 2-6. Average 1991 annual flow rates at BP-1, SBC-9, and TS-1 are higher than initial flow rates, while the average annual flow rate at SBC-6 is lower. The increase in flow at SBC-9 is due to the progression of mining into a wetter area of the mine (Co-Op Mining Company, 1992a). The decrease in flow rate at SBC-6 is likely due to the drought conditions of the last several years (Section 2.1.1). The cause of the higher flow rates measured at BP-1 and TS-1 is unknown.

Springs FBC-2 through FBC-6A are located in proposed Federal Lease U-024316 and adjacent areas (Plate 7-4 of this M&RP). These springs issue from the North Horn Formation (Co-Op Mining Company, 1992a) and flow intermittently (Table 2-7). FBC-6A is the largest of seven small springs monitored at FBC-6 (Table 2-7). Water flowing from these springs is absorbed by colluvium within 10 to 70 feet of each spring. These springs are not known to contribute to stream flow in the area (Co-Op Mining Company, 1992a).

TABLE 2-5

Initial Spring and Mine Water Flow Rates

Source	Date	Flow (gpm)
BP-1 (Ballpark Spring)	5/90	0.15
CS-1 (Trail Co-Op Spring)	5/90	NM
NPDES (Mine Discharge)	4/91	60
PS-1 (Portal Spring)	5/90	Dry
Roof Drips above Su-1	2/85	3 - 5
Roof Drips above Su-3	10/84	3 - 5
SBC-1 (Mine Water Sump)	2/86	Dry
SBC-4 (Big Bear Spring)	10/84	NM
SBC-5 (Birch Spring)	10/84	NM
SBC-6 (CoOp Dev. Spr)	9/86	12
SBC-7 (#33 West Spring)	2/90	1
SBC-8 (#30 East Spring)	2/90	<1
SBC-9 (Sump Su-3)	10/84	NM
Su-1	10/84	NM
TS-1 (Trail Canyon Spring)	5/90	0.5

NM = Not Measured

TABLE 2-6

1991 Average Spring and Mine Water Flow Rates

Source	Flow (gpm)	Number of Samples
BP-1 (Field)	0.38	2
CS-1 (Trail Co-Op Spring)	16	2
NPDES (Mine Discharge)	78	9
PS-1 (Portal Spring)	Dry	2
SBC-4 (Big Bear Spring)	119	8
SBC-5 (Birch Spring)	31	8
SBC-6 (CO-OP Develop. Spring)	Dry	4
SBC-9 (Mine Sump Su-3)	114	5
TS-1 (Trail Canyon Spring)	12.6	2

TABLE 2-7

Initial Spring Water Flow Rates (proposed Federal Lease U-024316)

Spring	June 1990	August 1991	October 1992
FBC-2	0.25 gpm	12 gpm	Dry
FBC-3	Dry	1.5 gpm	Dry
FBC-4	0.25 gpm	8.7 gpm	0.5 gpm
FBC-5	Dry	8.5 gpm	0.6 gpm
FBC-6	Dry	9.8 gpm	1.5 gpm
FBC-6A	NM	NM	1.1 gpm

NM = Not measured.

Three monitoring wells (SBC-2, SBC-3, and WM-C) were initially included in the groundwater monitoring program. SBC-2 is located immediately outside the mine portal (Co-Op Mining Company, 1992a) and the location of SBC-3 is presented on Plate 7-4 of this M&RP. There is no location information for WM-C and only one sample has been collected from this well (February 1985). Therefore, data from WM-C are not presented and are excluded from this discussion. Monitoring of SBC-2 was discontinued in 1991 because the well caved and was lost (1991 Annual Report). SBC-3 was damaged in 1990 and surface water began leaking into the well. In March 1992, SBC-3 was repaired and sealed (Co-Op Mining Company, 1992a). Static water levels and analytical data collected from 1990 through March 1992, are not representative of SBC-3 and have been excluded from the data set. This well has been dry throughout the balance of the period of record (Co-Op Mining Company, 1992a).

Groundwater enters the Blind Canyon Seam of the Bear Canyon Mine through fractures and roof bolt holes. Typically, water encountered by roof bolt holes flows moderately at first. Over a period of one or two months, flow decreases and eventually stops. Sources of these short-lived flows are inferred to be localized perched aquifers which store a limited amount of water (EarthFax Engineering, 1992, p. 2-19). This flow pattern is typical of the mines (Deer Creek, Plateau, and others) in the area (Danielson, et al., 1981).

Inflows through seven of eight exploratory borings into the Tank Seam (drilled up from the mine workings in the Blind Canyon Seam) are less than 0.1 gpm. The remaining boring (near the intersection of 3rd West and the 3rd West Bleeders) flows at 0.5 gpm. Thus, inflows to the proposed Tank Seam workings are expected to be less than those encountered in the Blind Canyon Seam.

Prior to 1991, mine water inflow was small and often insufficient to meet the operational needs of the mine (Chapter 7, M&RP). During 1991, mining proceeded into the northern portion of the permit area and groundwater inflow to the mine increased. During 1991, Co-Op Coal Company began discharging between 30 and 60 gpm from the mine. By January, 1992, mine discharge increased to 300 gpm and continued at this rate through

March, 1992 (Co-Op Mining Company, 1992a). Present total mine inflow is approximately 500 gpm. Of this total, 200 gpm is used in the mining operations, and 300 gpm is discharged to Bear Canyon Creek.

This increase in mine inflow is attributed to interception of perched aquifers by mining. Tritium analyses were performed on samples from four groundwater monitoring points (Birch Springs, Big Bear Springs, a North Mains roof dripper, and floor water) in order to define the relative ages of the groundwater in the permit and adjacent areas. Tritium values for Birch Springs (1.12 TU), North Mains (1.0 TU) and the Second East Bleeders floor sump (1.73 TU) (Plate 2, EarthFax Engineering, 1992) are within the same order of magnitude, whereas the value for Big Bear Springs (17.4 TU) is an order of magnitude greater, suggesting that the source of Big Bear Springs is different from that of the mine inflow and Birch Springs.

According to Thiros and Cordy (1991), prior to above-ground nuclear weapons tests conducted from 1953 to 1969, the natural tritium concentration in precipitation was 8.7 TU. Assuming a half-life of 12.26 years, tritium levels in groundwater stored since 1952 would now be 0.95 TU, thus, water collected from SBC-9 (North Mains) sample is likely 100% pre-bomb groundwater (water stored since before 1953). Waters from SBC-5 (Birch Spring) and SBC-10 (floor water) are probably mixtures rich in stored pre-bomb groundwater, with a slight amount of post-bomb water.

There are three possible explanations for the relatively high concentration of tritium in the SBC-4 (Big Bear Springs) water: 1) The groundwater could be freshly recharged; current tritium concentrations in freshly fallen rain water in Utah range between 10 and 20 TU (Thiros, 1992); 2) it could be stored post-bomb water which originally had a very high concentration of tritium which has since decayed; or 3) water from Big Bear Springs could be a mixture of pre-bomb and post-bomb waters.

Because tritium concentrations in rainwater were greater than 1000 TU during periods of active above-ground testing (Fritz and Fontes, 1980), the age of water from Big Bear Spring cannot be determined. Regardless of the source(s) of recharge to Big Bear Spring, the concentrations of tritium in the remaining groundwater samples (SBC-5, SBC-9, and SBC-10) suggest that Birch Spring water and the mine inflow are of similar age (pre-1953), and are not significantly recharged by modern precipitation.

Data presented in the Revised Hydrogeologic Evaluation of the Bear Canyon Mine Permit and Proposed Expansion Areas (EarthFax Engineering 1992, pp. 2-21 and 2-22) indicate there are three separate piezometric surfaces associated with the Panther, Storrs, and Spring Canyon tongues of the Star Point Sandstone. These aquifers are separated by mudstones, which serve as aquitards. Groundwater flow within these aquifers generally follows the regional dip of the Star Point Sandstone(0.5 to 1.5 degrees to the south and southeast). Hydraulic gradients in the Spring Canyon, Storrs, and Panther aquifers are 0.046, 0.050, and 0.053 feet per foot, respectively.

2.1.3 Groundwater Quality

Spring- and mine-water monitoring stations are sampled at various intervals throughout the year as a part of the Co-Op Coal Company hydrologic monitoring program (Plate 7-4 of this M&RP). A summary of water-quality analyses for groundwater samples collected is presented in Chapter 7 of the M&RP and in the Annual Hydrologic Monitoring Report (Co-Op Mining Company, 1990 and 1991). Groundwater-quality samples are routinely collected in the permit and adjacent areas from the underground bleeders, monitoring wells, and springs associated with faults and joints in the Panther Tongue of the Star Point Sandstone.

Table 2-8 presents analytical data from the first sampling event for each spring and mine water monitoring point. Locations of these monitoring points are presented on Plate 7-4 of this M&RP. The general character of the groundwater in the permit and adjacent areas is that of a calcium-bicarbonate water that is slightly alkaline and contains low concentrations of total dissolved solids (TDS), nutrients, and metals. Table 2-9 presents the average

TABLE 2-8

Initial Spring and Mine Water Analytical Results
(all values except pH expressed as mg/l)

Source	Date	TDS	TSS	Acid.[a]	Hard.[b]	Alk.[c]	Ca	Mg	Fe	Na	K	HCO_3	SO_4	Cl	NO_3	pH
BP-1 (Ballpark Spring)	5/90	402	11	0	382	302	68	51.4	0.07	13	3.3	368	82	13	NA	8.1
CS-1 (Trail Co-Op S)	5/90	402	4	0	392	336	76	48.1	0.09	5	3.0	410	61	11	NA	8
NPDES (Mine Disch.)	4/91	464	46	NA	NA	NA	NA	NA	0.19	NA	NA	NA	NA	NA	NA	7.8
PS-1 (Portal Spring)	5/90	Dry														
Roof Drips above Su-1	2/85	235	1	0	NA	216	46	35.0	0.03	3	1.4	NA	66	4	0.06	8.1
Roof Drips above Su-3	10/84	380	17	0	NA	314	60	38.4	0.12	19	3.7	383	40	2	0.03	7.3
SBC-1 (Mine Water)	2/86	280	2	NA	292	232	51	40	0.04	4	3.0	232	49	3	0.09	8

(a) Acidity as $CaCO_3$.
(b) Hardness as $CaCO_3$.
(c) Alkalinity as $CaCO_3$.
NA = Not analyzed.

TABLE 2-8 (Continued)

Initial Spring and Mine Water Analytical Results
(all values except pH expressed as mg/l)

Source	Date	TDS	TSS	Acid.[a]	Hard.[b]	Alk.[c]	Ca	Mg	Fe	Na	K	HCO_3	SO_4	Cl	NO_3	pH
SBC-4 (Big Bear Spring)	10/84	362	11	0	NA	254	80	22	0.33	26	0.97	310	27	50	0.24	7.4
SBC-5 (Birch Spring)	10/84	440	6	0	NA	310	64	59	0.12	12	2.0	378	80	30	0.04	7.9
SBC-6 (CO-OP Dev. Spr.)	9/86	458	NA	NA	331	291	83	30	0.5	5	1.0	355	1	6	0.05	8
SBC-7 (#33 West Spring)	2/90	Dry														
SBC-8 (#30 East Spring)	2/90	Dry														
SBC-9 (Sump Su-3)	10/84	300	5	0	NA	234	36	36	0.19	29	4.4	285	55	8	0.06	7.3
Su-1	10/84	362	11	0	NA	254	80	22	0.33	26	0.97	309	27	50	0.24	7.4
TS-1 (Trail Cyn. Spring)	5/90	410	1	0	382	287	72.3	49	0.13	12	3.2	349	84	16	NA	8.1

(a) Acidity as $CaCO_3$.
(b) Hardness as $CaCO_3$.
(c) Alkalinity as $CaCO_3$.
NA = Not analyzed.

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TABLE 2-9

1991 Average Groundwater Analytical Results
(all values except pH expressed as mg/l)

Source	TDS	TSS	Acid.[a]	Hard.[b]	Alka.[c]	Ca	Mg	Fe	Na	K	HCO_3	SO_4	Cl	NO_3	pH	Number of Samples
BP-1 (Field)	451	NA	NA	399	NA	82	47	0.56	11	3.8	437	62	11.0	NA	8.0	2
CS-1 (Trail Co-Op S)	380	NA	NA	309	NA	79	27	0.36	4.9	2.5	320	63	4.6	NA	7.9	2
NPDES (Mine Disch.)	371	13	NA	NA	NA	NA	NA	0.11	NA	NA	NA	NA	NA	NA	7.9	9
PS-1 (Portal Sp)	Dry															
SBC-4 (Big Bear Spring)	381	5	NA	347	291	84	34	0.15	4.9	2.0	352	65	7.8	ND	7.7	8
SBC-5 (Birch Spring)	485	0.9	0	440	276	102	45	0.06	6.5	2.4	382	126	12.0	0	7.5	8
SBC-6 (CO-OP Dev. Spr)	Dry															
SBC-9 (Mine Sump Su-3)	360	0.5	NA	325	275	77	35	0.17	4.2	1.7	355	57	4.4	ND	7.9	5
TS-1 (Trail Cyn Spring)	452	NA	NA	389	NA	83	44	0.17	13	3.0	399	84	11.6	NA	8.0	2

(a) Acidity as $CaCO_3$.
(b) Hardness as $CaCO_3$.
(c) Alkalinity as $CaCO_3$.
NA = Not analyzed.
ND = Not detected.

analytical results from 1991 groundwater sampling documented in the 1991 Annual Report. The general character of the groundwater in 1991 is also that of a slightly alkaline calcium-bicarbonate water that contains low concentrations of TDS, nutrients, and metals. Average iron concentrations increased significantly in BP-1 water. This is due to a single high value of 0.97 mg/l detected in October 1991 (1991 Annual Report).

Analytical results for groundwater sampled in 1991 and 1992 at proposed Federal Lease U-024316 monitoring points FBC-2 through FBC-6A are presented in Tables 2-10 and 2-11, respectively. The character of the groundwater defined in these initial surveys is similar to and within the range of chemical concentrations found in the present permit initially (Table 2-8) and in 1991 (Table 2-9). Sulfate and chloride concentrations increase from 1991 to 1992 in FBC-4, FBC-5, and FBC-6 waters. All other chemical concentrations did not change significantly from 1991 to 1992 in waters sampled at FBC-2 through FBC-6.

Figure 2-1 presents a Piper diagram of average analytical results of the sampling events in 1991 for 6 groundwater monitoring points: Birch Spring (SBC-5, eight samples), North Mains (SBC-9, five samples), Ball Park Spring (BP-1, two samples), Big Bear Spring (SBC-4, eight samples), Co-Op Spring (CS-1, 2 samples), and Trail Canyon Spring (TS-1, 2 samples). The Piper diagram is divided into three fields: cations, anions, and the combined field. Values are in percent milliequivalents, and are plotted in the anion and cation fields and projected into a combined field. Spatial relationships of samples that are similar among the three fields are indicative of hydraulic connection between waters. Spatial relationships among the six waters are not the same in all three fields; thus, it is inferred that the waters are not hydraulically connected. Birch Spring has the least similarity to the other waters. For example, Birch Spring water plots very close to mine water in the cation field, but it plots as an outlier in the anion field and in the combined field. This is due to a higher percentage of sulfate in Birch Spring water than in the mine water or the other spring water in the area. In fact, the mine water and BP-1 water have the lowest percentages of sulfate of the groundwater represented in the Piper diagram. Thus, the spatial relationships exhibited in the Piper diagram suggest that the mine water is of a higher quality than Birch Spring water. Furthermore, the difference

TABLE 2-10

1991 Spring and Mine Water Analytical Results (proposed Federal Lease U-024316)
(all values except pH expressed as mg/l)

Source	Date	TDS	TSS	Acid.[a]	Hard.[b]	Alka.[c]	Ca	Mg	Fe	Na	K	HCO_3	SO_4	Cl	NO_3	pH
FBC-2	8/91	352	NA	NA	305	NA	77.8	26.9	7.60	4.90	0.89	379	5.76	2.33	0.00	8.05
FBC-3	8/91	274	NA	NA	258	NA	72.4	18.8	0.22	3.50	0.84	307	12.3	2.43	0.38	8.00
FBC-4	8/91	396	NA	NA	326	NA	86.3	27.0	9.51	4.60	3.40	391	8.64	5.27	0.00	7.50
FBC-5	8/91	328	NA	NA	302	NA	81.7	23.9	1.24	5.80	2.91	367	13.0	7.20	0.00	8.00
FBC-6	8/91	272	NA	NA	261	NA	69.2	21.5	0.10	5.10	0.61	303	15.0	5.27	0.29	8.40

(a) Acidity as $CaCO_3$.
(b) Hardness as $CaCO_3$.
(c) Alkalinity as $CaCO_3$.
NA = Not analyzed.

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TABLE 2-11

1992 Spring and Mine Water Analytical Results (proposed Federal Lease U-024316)
(all values except pH expressed as mg/l)

Source	Date	TDS	TSS	Acid.[a]	Hard.[b]	Alka.[c]	Ca	Mg	Fe	Na	K	HCO_3	SO_4	Cl	NO_3	pH
FBC-2	10/92								Dry							
FBC-3	10/92								Dry							
FBC-4	10/92	318	NA	NA	342	NA	66.1	42.9	0.00	6.83	0.27	314	90.0	10.0	0.43	7.26
FBC-5	10/92	149	NA	NA	319	NA	103.8	14.6	0.10	1.81	0.00	328	9.00	25.0	0.10	7.68
FBC-6	10/92	277	NA	NA	280	NA	60.4	31.3	0.67	3.83	2.64	368	28.0	15.0	0.04	7.80
FBC-6A	10/92	814	NA	NA	359	NA	94.1	30.0	0.60	3.91	89.7	410	35.0	25.0	0.09	7.82

(a) Acidity as $CaCO_3$.
(b) Hardness as $CaCO_3$.
(c) Alkalinity as $CaCO_3$.
NA = Not analyzed.

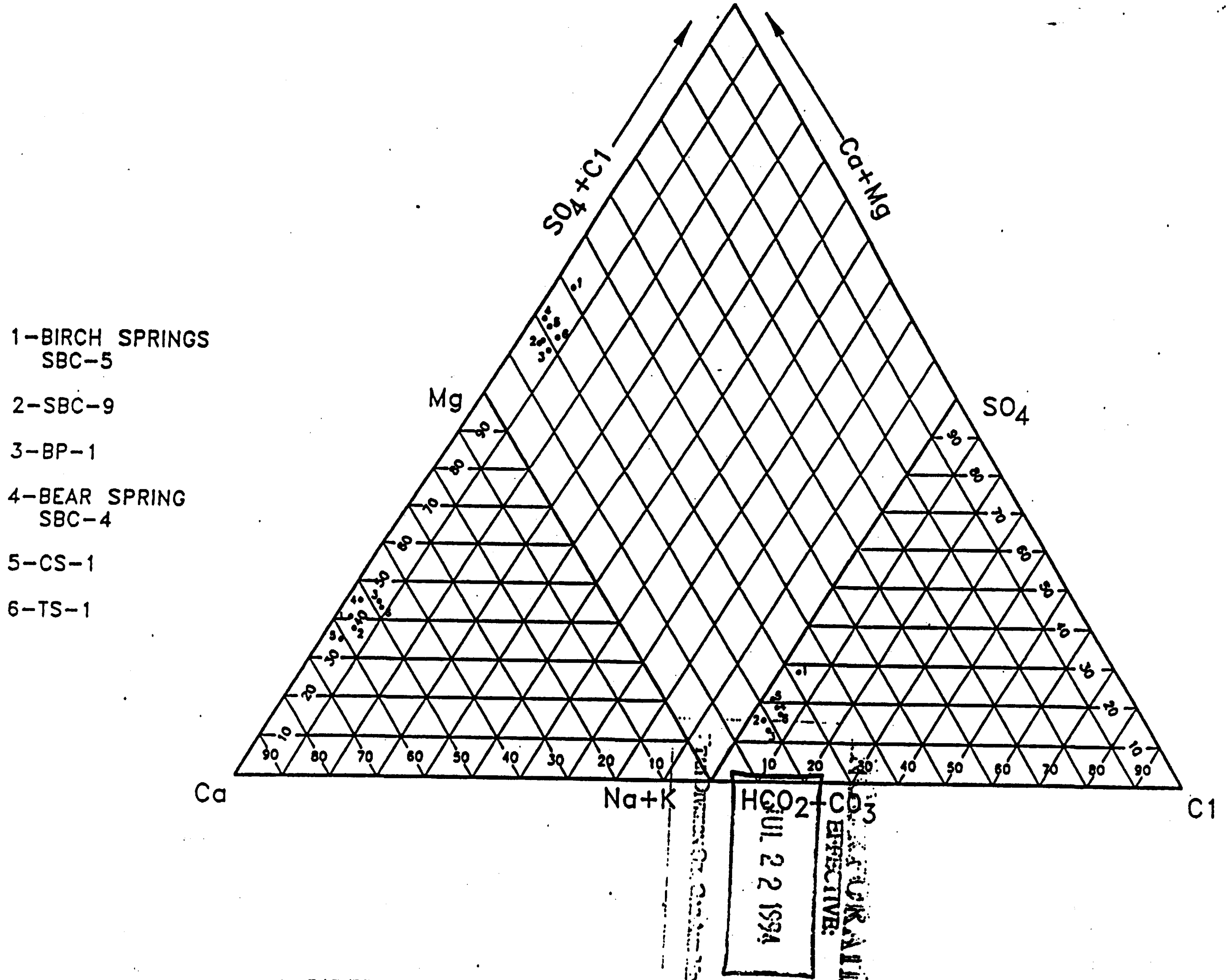

FIGURE 2-1. PIPER DIAGRAM OF AVERAGE GROUNDWATER ANALYTICAL RESULTS

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in spatial relationships in the different fields suggests the waters are not hydraulically connected.

Figure 2-2 presents a series of Stiff diagrams which characterize waters from the same six groundwater monitoring points used in Figure 2-1. The six waters display a similar Stiff pattern, that of a calcium-bicarbonate water. Additionally, the Stiff patterns indicate that SBC-9 (North Mains) water has the lowest sulfate concentration (1.18 meq) and SBC-5 (Birch Spring) has the highest sulfate concentration (2.62 meq) of the groundwater sampled. SBC-4 (Big Bear Spring) water has a sulfate concentration of 1.36 meq. SBC-9 also has the lowest chloride value of the groundwaters sampled. This relationship between the sulfate and chloride concentrations does not suggest that the mine water could diminish the quality of the spring water in the area.

The major portion of water inflow to the mine is used within the mine or for culinary purposes by Co-Op Mining Company. According to the Co-Op Bear Canyon Mining and Reclamation Plan, the water which flows from Big Bear Spring (also called Huntington Spring) and Birch Spring is used by the Huntington community for culinary purposes (Co-Op Mining Company, 1990). Water collected in Trail Canyon from TS-1 (Trail Canyon Spring) is also used by Trail Canyon residents for culinary purposes.

Wells in the permit and adjacent areas are either observation wells owned by Co-Op Mining, or exploration wells owned by Northwest Energy. Three new monitoring wells (DH-1A, DH-2, and DH-3, Plate 1, EarthFax Engineering, 1992) were drilled within the permit area for this study. DH-1A and DH-2 were drilled in late 1991 and DH-3 was drilled in early 1992. The three wells were completed in the Spring Canyon Tongue of the Star Point Sandstone, and were developed, tested, and sampled in May, 1992. The results of laboratory analyses of the monitoring well samples are summarized on Table 2-12 from the complete analytical reports (Appendix 7N-H, EarthFax Engineering, 1992).

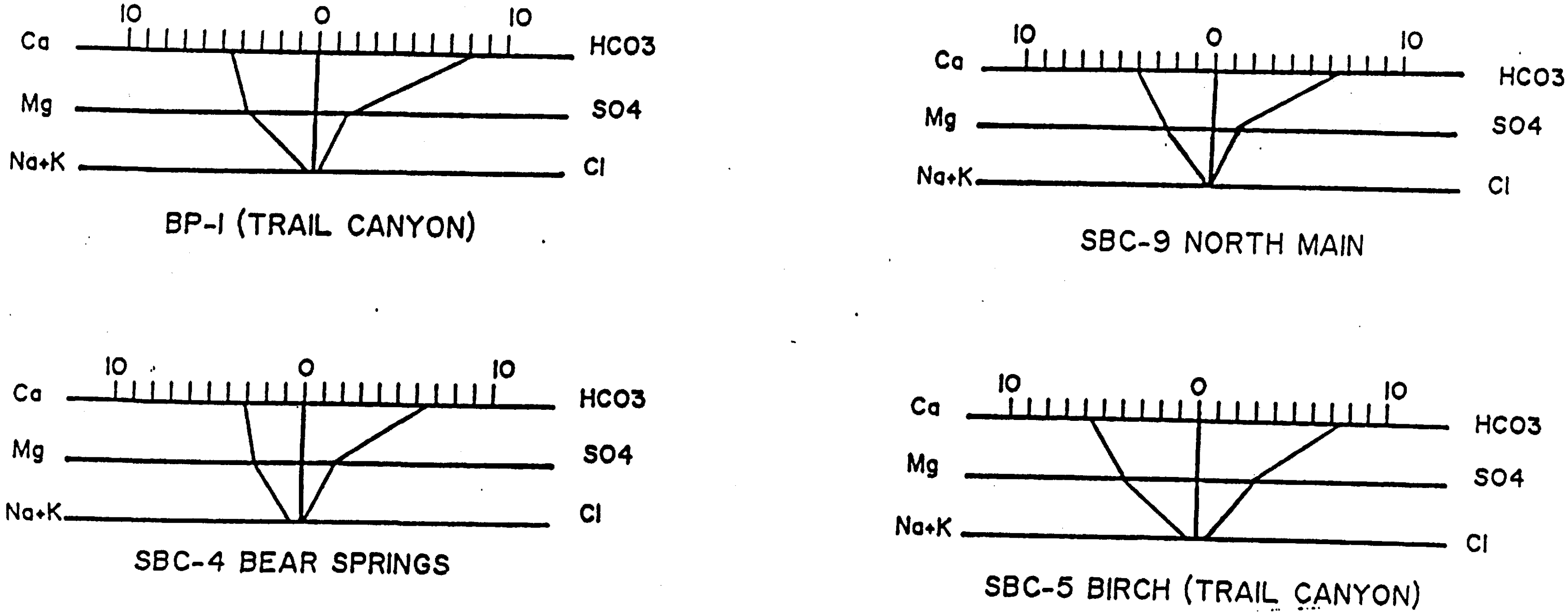

FIGURE 2-2. **Stiff Diagrams of Spring Water Analytical Results**

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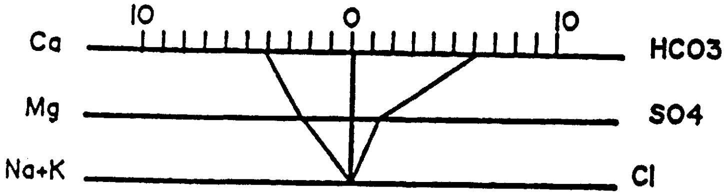
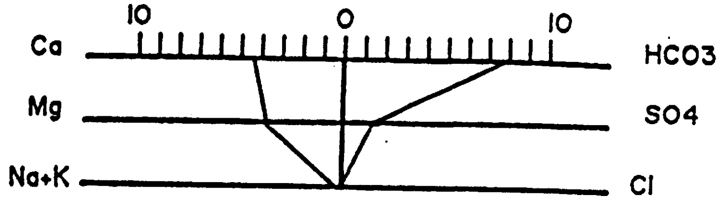


CS-1 CO-OP SPRING (TRAIL CANYON)



TS-1 TRAIL CANYON SPRING

FIGURE 2-2 (continued). **Stiff Diagrams of Spring Water Analytical Results**

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TABLE 2-12

Summary of Laboratory Analytical Results for Groundwater From In-Mine Monitoring Wells

ANALYTE (mg/l)	DH-1A	DH-2	DH-3
Aluminum	0.2	<0.1	<0.1
Arsenic	<0.05	<0.05	<0.05
Barium	0.071	0.127	0.129
Cadmium	<0.01	<0.01	<0.01
Calcium	38.9	51.9	50.9
Chromium	0.025	<0.01	<0.01
Copper	<0.01	<0.01	<0.01
Iron	0.505	0.280	0.220
Lead	<0.01	0.030	<0.01
Magnesium	20.1	29.5	28.9
Manganese	0.062	0.101	0.232
Mercury	<0.0005	<0.0005	<0.0005
Molybdenum	0.058	0.010	<0.01
Nickel	<0.01	<0.01	<0.01
Potassium	31.2	1.5	2.6
Selenium	<0.0005	<0.0005	<0.0005
Sodium	14.1	8.8	15.2
Zinc	<0.01	<0.01	<0.01
Oil & Grease	2.0[a]	<0.5	<0.5

[a] Oil and Grease expected (hydraulic fluid leak on rig).

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TABLE 2-12 (Continued)

Summary of Laboratory Analytical Results
for Groundwater From In-Mine Monitoring Wells

ANALYTE (mg/l)	DH-1A	DH-2	DH-3
TDS	285	330	339
Hardness as CaCO3	162	321	307
Boron	<0.05	0.064	0.061
Alkalinity as CaCO3	94	285	294
Bicarbonate	110	340	336
Carbonate	2.3	3.5	11.5
Hydroxide	0	0	0
Chloride	4.9	4.2	4.2
Fluoride	0.28	0.18	0.16
Ammonia	<0.2	0.64	0.22
Nitrate	0.42	0.74	<0.5
Phosphate	0.129	0.25	0.027
Sulfate	128	33	38
Sulfide	<0.1	<0.1	<0.1

Figure 2-3 presents Stiff diagrams of ions in groundwater from the in-mine wells. Waters from DH-1A and DH-3 have Stiff patterns similar to those of the calcium-bicarbonate spring water depicted on Figure 2-2. Water from DH-2 has a calcium, magnesium, sodium, potassium-sulfate pattern. This pattern is distinctly different from other groundwater that has been sampled in the permit and adjacent areas, and is presumed to be due to the dissolution of locally-occurring sulfate salts.

Groundwaters sampled from the in-mine wells have a TDS range of 285 to 339 mg/l. Dissolved iron and manganese concentrations range from 0.220 to 0.505 mg/l and from 0.062 to 0.232 mg/l, respectively.

Groundwater quality analyses (1991 Annual Report) were compared to the primary drinking water standards (40 Code of Federal Regulations (CFR) 141) and the secondary drinking water standards (40 CFR 143). In September 1991, a chromium concentration of 0.06 mg/l was detected in water sampled from SBC-5 (Birch Spring), exceeding the chromium standard of 0.05 mg/l. There were no analyses for silver.

One exceedance of the secondary drinking water standards was detected for the mine water samples; in August 1991, an iron concentration of 0.55 mg/l was detected in water from SBC-9 (Mine Sump #3), exceeding the iron standard of 0.3 mg/l. Additionally, exceedances of iron, manganese, and TDS standards were found in groundwater sampled in 1991. These exceedances constituted fifteen percent of iron, five percent of manganese, and ten percent of TDS analyses performed on these respective constituents. It should be noted that the secondary drinking water standards "represent reasonable goals for drinking water quality," (40 CFR 143) and are not mandatory standards.

2.2 POTENTIAL GROUNDWATER IMPACTS

Potential groundwater impacts that could result from mining and reclamation operations at the Bear Canyon Mine include:

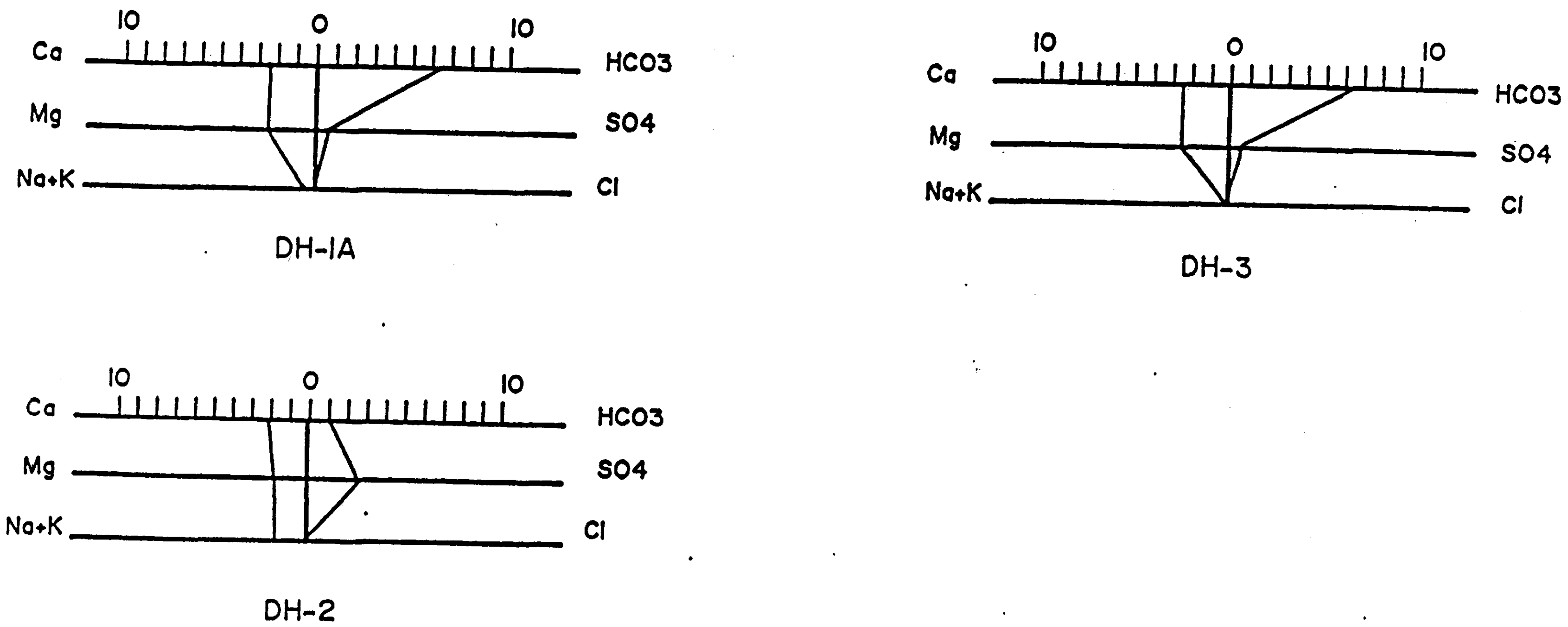

FIGURE 2-3. **Stiff Diagrams of In-Mine Monitoring Well Analytical Results**

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- o Contamination from acid- or toxic- forming materials;
- o Impacts to groundwater quantity; and
- o Impacts to groundwater quality:
  - Contamination due to rock dust usage,
  - Contamination due to the use of hydrocarbons, and
  - Contamination from road salting.

2.2.1 Potential Contamination from Acid- and Toxic-Forming Materials

Information on acid- or toxic-forming materials monitoring is presented in Appendix 6-C of the M&RP. Evaluation of these data using Table 2 in the Guidelines for Management of Topsoil and Overburden (Leatherwood and Duce, 1988) revealed that there have been no poor or unacceptable (acid- or toxic-forming) materials encountered in the permit area. Co-Op Mining Company mined through a small, highly localized sulfur-bearing mineral zone in January and March, 1992, but no waste rock was produced as the sulfur-bearing minerals were sold with the coal (Co-Op Mining Company, 1992a). In addition, as noted in Section 2.1.3 of this PHC, the alkalinity of the groundwater in the area is approximately 300 times the acidity. No waste rock is expected to be produced in the future (Co-Op Mining Company, 1992a).

Given past experience at the mine and the generally alkaline nature of the groundwater, the probability of acid- and/or toxic-forming materials being found or produced from the mine in the future is low. However, if any of these materials are discovered in waste rock in the future through the on-going monitoring plan, these materials will be disposed of in accordance with the requirements of Utah Mining Regulations R645-301-731.300 and as outlined in Chapter 3 of the M&RP.

2.2.2 Groundwater Quantity Impact

Mining will remove groundwater both from formations adjacent to the coal seams and from mine-water contained in the coal itself. The removal of water from the surrounding formations occurs when groundwater flows into the underground mine workings as the coal

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is removed. Drainage of water from faults and fractures produces the largest volume of water flowing into the mine (EarthFax Engineering, 1992, pp. 2-17 and 2-19). As noted in Section 2.1.2, the volume of groundwater flow into the mine has only recently increased sufficiently to produce water in excess of that needed for mine operations.

Groundwater flows into the Bear Canyon Mine at a rate of 500 gpm. 200 gpm are used in the mine operations and 300 gpm are discharged into Bear Creek. A minimum of one third of the water used in the mine operations is returned to the groundwater regime because the majority of this water is used for dust suppression within the mine. The balance of the mine water is utilized at the surface facilities for culinary water and dust suppression on surface roads (Co-Op Mining Company, 1992a).

The approximate *in situ* moisture content of coal mined in the Bear Canyon Mine is 5.3 percent water by weight (this does not include moisture added from dust suppression, Appendix 6-B, M&RP). This water leaves the mine in the coal as part of the mining process. Using an extraction rate of 432,140 tons of coal for 1991, approximately 18 acre-feet of water will be diverted annually in the coal from the groundwater system. Based on a long-term coal production rate of 500,000 tons per year, approximately 22 acre-feet of water per year will be diverted from the groundwater system. However, because most of this water is perched (not connected to surface springs), its removal will have little or no effect on spring flow in the area.

Springs presently monitored in proposed Federal Lease U-024316 issue from the North Horn Formation and are perched (EarthFax Engineering, 1992, p. 2-11) at least 1000 feet above the top of the Blind Canyon coal seam (Plate 7-4 in this M&RP). Thus, mine dewatering is not expected to impact these springs.

Figure 2-4 depicts drawdown expected at distances measured along the long (D_y) axis and the short (D_x) axis of the mine. Based on a mine life of 20 years (Co-Op Mining

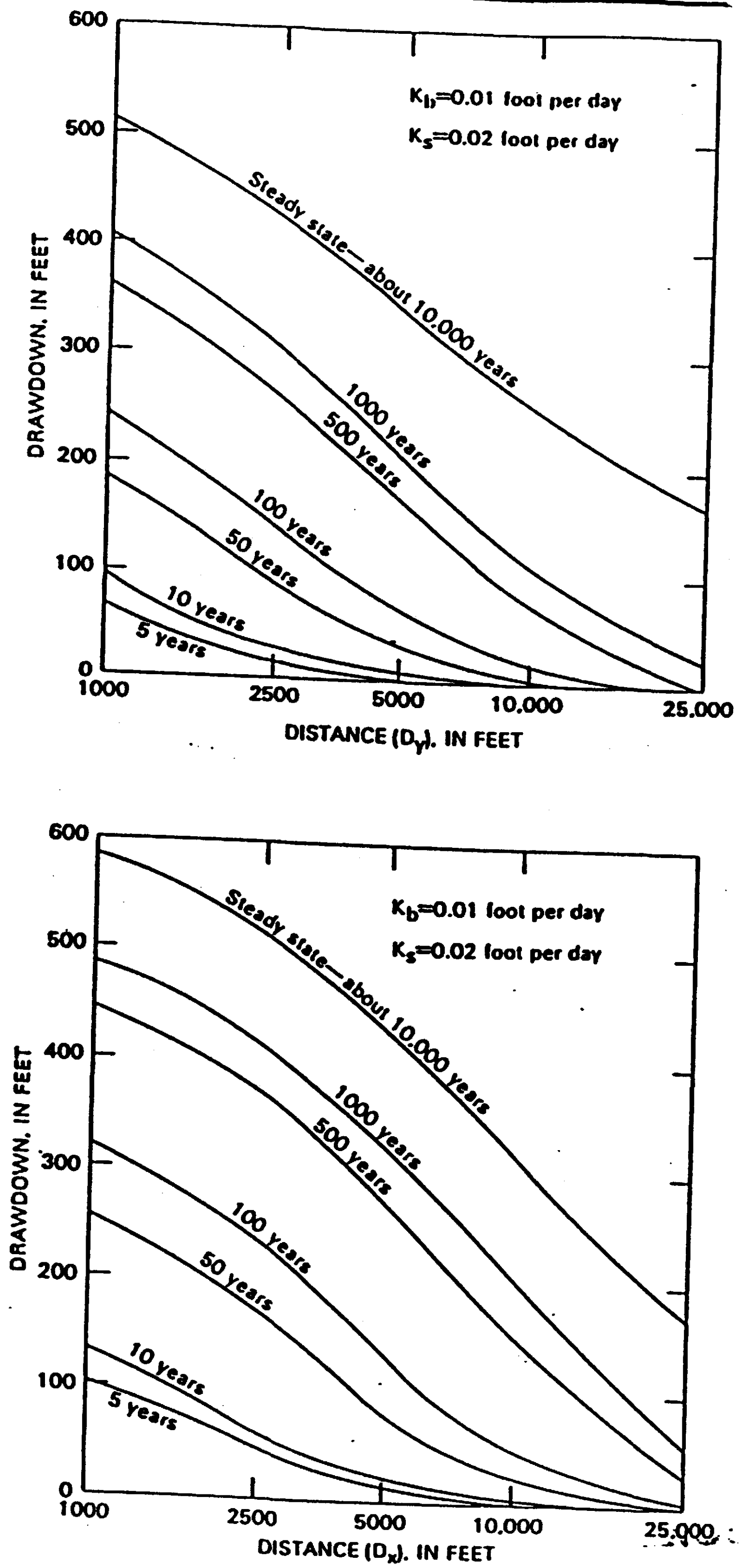

FIGURE 2-4. PREDICTED DRAWDOWN AS A FUNCTION OF DISTANCE (LINES, 1985)

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Company, 1992a), the maximum expected lateral limits of the cone of depression caused by dewatering of the Bear Canyon Mine would be approximately 9,000 feet (1.7 miles) from the mine boundary in the north and south directions and 15,000 feet (2.8 miles) from the mine boundary in the east-west directions. This drawdown terminates wherever the strata immediately above the coal seams being mined are truncated by canyons as in Bear, Blind, and Trail Canyons.

There are no water supply wells located in the permit and adjacent areas. As indicated in the baseline data discussed in Section 2.1.2 of this PHC, there are three springs located above the coal seam in the northern proposed expansion area. There are no water rights associated with these springs (EarthFax Engineering, 1992, p. 2-38).

Because the aquifers that supply springs above the Blind Canyon coal seam are perched, mining operations will have no effect on spring flow or spring water quality (EarthFax Engineering, 1992, pp. 2-23 thru 2-30). It is unlikely that Bear Canyon Mine will impact Birch and Big Bear Springs for six reasons:

1. Tritium data indicate that the source of groundwater inflow to the mine is not the same as the source of Big Bear Springs (the Panther Tongue of the Star Point Sandstone), but perched aquifers containing relict stored water (Section 2.1.2).

2. Stiff and Piper diagrams indicate that the mine water is of a higher quality than that of the other waters in the area and that Birch Spring and the mine water are not hydraulically connected (Section 2.1.3).

3. Information collected during the drilling of the three in-mine monitoring wells suggests that the mine workings may intercept groundwater from the Spring Canyon Tongue of the Star Point Sandstone. However, both Birch and Big Bear Springs issue from the Panther Tongue, which is the lowest tongue of the Star Point Sandstone and 400 feet below the Blind Canyon seam (EarthFax Engineering, 1992, p. 2-17 and Appendix 7N-G).

4. The mine and Birch Spring are separated by a complex zone of fractures and faults. The Blind Canyon Fault is a normal fault with 220 feet of vertical displacement and is located near the western limit of mining in the Bear Canyon Mine. This fault could act either as a conduit (if it has open voids) or as a

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barrier (if it is filled with gouge) to groundwater flow. In either case, the fault would probably prevent groundwater from moving from the mine to Birch Spring. If the fault did not act as a barrier, it would convey the water moving within it to the surface as a spring. No such spring is present where the Blind Canyon fault intersects the surface, approximately 800 feet east of Birch Spring.

5. Birch Spring is approximately 8,500 feet from the North Mains section of the mine. The linear velocities calculated for the aquifers of the Star Point Sandstone range from 1.31 to 69.75 feet per year (Section 2.1.2). At the fastest calculated velocity, impact to water quality and quantity at Birch Spring from water in the mine would not occur for at least 122 years.

   Lines (1985) presented laboratory determinations of porosity (ranging from 2 to 17 percent) and horizontal hydraulic conductivities (ranging from 1.1×10^{-8} to 3.1×10^{-2} feet per day). Using these data and the maximum hydraulic gradient measured in the in mine drill holes of 0.053 feet per foot (Section 2.1.2), the fastest calculated velocity is 29.98 feet per year. At this velocity, the mine water would not impact Birch Spring for 283 years.

6. Three piezometric surfaces in the Spring Canyon, Storrs, and Panther Tongues of the Star Point Sandstone have been defined by EarthFax Engineering (1992, pp. 2-21 and 2-22) through drilling and testing (Plates 3, 4, and 5, EarthFax Engineering, 1992). The hydraulic gradients are to the south (parallel to the Blind Canyon Fault) and to the southeast (away from the Blind Canyon Fault) (Plate 1, EarthFax Engineering, 1992).

Discharge of groundwater from the underground workings and removal of groundwater in the coal is expected to continue through the life of the mining operation. To date, no negative impact to seeps or springs has been demonstrated. The springs which issue from the perched aquifers will probably remain unaffected by the dewatering. In addition, as noted above, impacts to groundwater availability from the Panther Tongue of the Star Point Sandstone (Birch and Big Bear Springs) in the permit and adjacent areas is unlikely.

2.2.3 Potential Groundwater Quality Impacts

Potential groundwater quality impacts include:

o Contamination due to rock dust usage;

- o Contamination due to usage of hydrocarbons; and
- o Contamination from road salting.

Rock Dust Usage Impact. The practice of using rock dust for the suppression of coal dust in the mine may potentially impact the groundwater flowing through the mine by dissolution of the rock dust constituents into the water. The use of gypsum rock dust can raise the TDS and sulfate concentrations in the groundwater. Until recently, Co-Op Mining Company used a non-gypsum rock dust. In 1990, use of gypsum rock dust began (Co-Op Mining Company, 1992a).

During January and March, 1992, TDS concentrations were detected that exceed the NPDES Permit guidelines for discharge from the Bear Canyon Mine. Gypsum used in rock dusting is considered to have contributed to the high TDS concentrations. Co-Op Mining Company now uses only lime dust in the Bear Canyon Mine (Co-Op Mining Company, 1992b). Due to the relative dryness of the mine, no future increase in TDS or sulfate concentrations in the groundwater is expected.

Impact of Hydrocarbons. Hydrocarbons (in the form of fuels, greases, and oils) are stored and used in the permit area. Groundwater contamination could result from spillage of hydrocarbon products during maintenance of equipment during operations, filling of storage tanks and vehicle tanks, or from tank leakage due to the rupture of tanks.

The probable future extent of the contamination caused by diesel and oil spillage is expected to be small for six reasons.

1. All above-ground storage tanks are bermed and inner and/or outer catchments are utilized in accordance with the 1992 Spill Prevention Control and Countermeasure Plan (SPCC).
2. No underground storage tanks exist at the site.
3. Because the tanks are located above ground, leakage from the tanks can be readily detected and repaired.

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4. Spillage during filling of the storage or vehicle tanks is minimized to avoid loss of an economically valuable product.

5. The surface operations area is drained by a series of ditches, which feed into a sedimentation pond at the lower end of the disturbed area.

6. The 1992 SPCC Plan provides (and Co-Op Mining Company has implemented) inspection and operation measures to minimize the extent of contamination resulting from the use of hydrocarbons at the site.

There are no transformers in the mine permit area which contain polychlorinated biphenyls (PCBs).

Road Salting Impact. Co-Op Mining Company utilizes salt to maintain the roads within the permit area in the winter. Road salt could contaminate the groundwater if sufficient amounts of salt were stored on, or washed into recharge areas.

Co-Op Mining Company salts 2,100 feet of road in the winter (this will be increased to 4,200 feet with the addition of the proposed Tank Seam access road). The potential for impact to the groundwater is low and not likely to occur; however, because the steepness of the canyon allows very little recharge within the permit area. Salt is stored by Emery County outside the permit area (Co-Op Mining Company, 1992a).

3.0 SURFACE WATER

3.1 BACKGROUND INFORMATION

Detailed information on surface water and the physical resources that effect surface water is found in Chapter 7 of the M&RP and in the Revised Hydrogeologic Evaluation of the Bear Canyon Mine Permit and Proposed Expansion Areas (EarthFax Engineering, 1992). This information is summarized herein for convenience. These documents should be consulted for more detail.

3.1.1 Hydrology

The Bear Canyon Mine is located in the San Rafael River Basin. Within the permit area, Bear Creek is a perennial stream and Trail Creek is an intermittent stream. On the southern end of the permit area, ephemeral streams discharge into Huntington Creek, a perennial stream (Chapter 7, M&RP).

All streams in the permit and adjacent areas are classified by the Utah Department of Health as follows:

- o 1C Protected for domestic use with prior treatment processes,
- o 3A Protected for cold water aquatic life, and
- o 4 Protected for agricultural uses including stock watering.

The primary source of water for the streams in the area is snowmelt (Danielson, 1981). Hence, peak flows generally occur in the late spring and early summer. The 1989 annual watershed yield of the Huntington Creek drainage measured upstream from the bridge to Deer Creek Mine is 21,449 ft^3 (Water Resources Division, USGS, 1992).

Seasonal variations in perennial stream flow monitored in Huntington Creek during 1989 range from 4,100 to 66,000 gpm, averaging 22,000 gpm. These extremes in flow rates are typical of high elevation locations in the western United States and are graphically displayed in the Revised Hydrogeologic Evaluation of the Bear Canyon Mine Permit and Proposed Expansion Areas (1992, Appendix 7N-B).

Flow rates for Bear Creek are monitored at BC-1, BC-2, and BC-3, while flow rates for Trail Canyon are monitored at UT-1 and LT-1. The sediment pond inlet is monitored at SP-1. Locations of these monitoring points are presented on Plate 7-4 of this M&RP. Flow rates measured during the initial monitoring of flow rates for each of these monitoring points are presented in Table 3-1. Monitoring points BC-3, SP-1, and UT-1 were dry. Table 3-2 presents the average annual flow rates for surface water in 1991. Average flow rates recorded at BC-2 during 1991 are higher than the initial flow (due to mine water discharge from the NPDES discharge point). Average flow rates at LT-1 are also higher than initial flows (due to one high flow rate recorded in October 1991). There is no corresponding increase at BC-1, and no cause for this increase is known.

Annual monitoring of proposed Federal Lease U-024316 surface water monitoring point FBC-1 began in 1990. In August 1991, the intermittent stream monitored at FBC-1 flowed through McCadden Hollow at the rate of 1.5 gpm. It was dry in June 1990 and October 1992 (Appendix 7-M of this M&RP).

3.1.2 Water Quality

Sediment Yield. Danielson (1981) collected water samples from Bear Creek during 1978 and 1979 in order to determine total suspended solids (TSS) concentrations and loads of the stream. Analyses of these samples yielded TSS concentrations of 8,860 and 2,140 mg/l and loads of 1.9 and 4.0 tons/day. Danielson attributes TSS concentrations in Bear Creek to erosion of shales and mudstones in the North Horn Formation by the springs that feed Bear Creek.

TABLE 3-1

Initial Surface Water Flow Rates

Source	Date	Flow (gpm)
BC-1 (Upper Bear)	11/84	26.0
BC-2 (Lower Bear)	12/84	26.8
BC-3 (Right Fork Bear)	1/86	Dry
LT-1 (Lower Trail)	5/90	29
SP-1 (S. Pond Inlet)	5/90	Dry
UT-1 (Upper Trail Creek)	5/90	Dry

TABLE 3-2

1991 Average Surface Water Flow Rates

Source	Flow (gpm)	Number of Measurements
BC-1 (Upper Bear)	27	7
BC-2 (Lower Bear)	100	7
BC-3 (Right Fork Bear)	Dry	7
LT-1 (Lower Trail Creek)	47	2
SP-1 (Sed Pond Inlet)	Dry	2
UT-1 (Upper Trail Creek)	Dry	2

<u>Chemical Quality.</u> Surface water quality samples are routinely collected in the permit and adjacent areas from stations located on Bear Creek and Trail Creek. Analytical data from these sources are summarized in Chapter 7 of the M&RP and the Annual Reports. Locations of these monitoring points are presented on Plate 7-4 of the M&RP.

Table 3-3 presents analytical results from the initial sampling of each surface water monitoring point. The general character of the surface water is that of a slightly alkaline calcium-bicarbonate water containing low concentrations of TDS, nutrients and metals. Three (BC-3, SP-1, and UT-1) out of the six surface water monitoring points have been dry, historically. The source of the high TSS concentration detected at BC-1, is unknown, but occurs upstream of the mine, and is not considered to be mine-related.

Chemical analyses presented in the 1991 Annual Report were averaged for each monitoring point and are presented in Table 3-4. These data indicate that the general character of the surface water is also that of a slightly alkaline calcium-bicarbonate water, low in concentrations of nutrients. However, average TDS, TSS, calcium, magnesium, iron, and sulfate concentrations in BC-1 and BC-2 are significantly higher than the corresponding initial concentrations. Comparison of initial and average 1991 analytical results for LT-1 water indicate that chemical concentrations at this station are relatively unchanged.

Table 3-5 presents 1991 and 1992 initial data for proposed Federal Lease U-024316 surface water monitoring point FBC-1. These chemical concentrations correlate closely to the chemical concentrations of LT-1 water (Tables 3-3 and 3-4).

Total dissolved solids content in BC-1, BC-2, and LT-1 waters measured in 1991 range from 404 to 1810 mg/l (1991 Annual Report). Anomalously elevated TDS concentrations (accompanied by high TSS, calcium, magnesium, iron, and sulfate concentrations) were detected in BC-1 and BC-2 water collected during February 1991. These elevated concentrations occur both upstream and downstream of the mine,

TABLE 3-3

Initial Surface Water Analytical Results
(all values except pH expressed as mg/l)

Source	Date	TDS	TSS	Acid.(a)	Hard.(b)	Alka.(c)	Ca	Mg	Fe	Na	K	HCO_3	SO_4	Cl	NO_3	pH
BC-1 (Upper Bear)	11/84	415	1620	0	NA	200	43	57.0	4.8	8.0	3.5	NA	161	4.0	0.47	8.1
BC-2 (Lower Bear)	10/84	375	13.5	0	NA	200	50	50.4	19.8	7.1	5.77	244.0	116	20.0	0.14	8.1
BC-3 (Rt Fk Bear)	1/86	Dry														
LT-1 (Lower Trail)	5/90	472	6	0	412	355	72.3	56.2	0.32	17.6	3.9	433.4	88.5	14.7	NA	8.1
SP-1 (S. Pond Inlet)	5/90	Dry														
UT-1 (Upper Trail Creek)	5/90	Dry														

(a) Acidity as $CaCO_3$.
(b) Hardness as $CaCO_3$.
(c) Alkalinity as $CaCO_3$.
NA = Not analyzed.

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TABLE 3-4

1991 Average Surface Water Analytical Results
(all values except pH expressed as mg/l)

Source	TDS	TSS	Acid.[a]	Hard.[b]	Alka.[c]	Ca	Mg	Fe	Na	K	HCO_3	SO_4	Cl	NO_3	pH	Number of Samples
BC-1 (Upper Bear)	783	623	0	656	262	113	95	26.3	13	6.4	313	430	9.5	NA	8.0	4
BC-2 (Lower Bear)	793	342	0	613	308	51	113	4.0	11	5.2	370	323	9.3	NA	8.0	4
BC-3 (Rt. Fk. Bear)	Dry															
LT-1 (Lower Trail Cr.)	476	1	NA	398	NA	70	54	0.13	18.5	4.7	401	85	20.0	NA	8.0	2
SP-1 (S Pond Inlet)	Dry															
UT-1 (Upper Trail Cr)	Dry															

(a) Acidity as $CaCO_3$.
(b) Hardness as $CaCO_3$.
(c) Alkalinity as $CaCO_3$.
NA = Not analyzed.
NS = Not sampled.

TABLE 3-5

Surface Water Analytical Results (proposed Federal Lease U-024316)
(all values except pH expressed as mg/l)

Source	Date	TDS	TSS	Acid.[a]	Hard.[b]	Alka.[c]	Ca	Mg	Fe	Na	K	HCO_3	SO_4	Cl	NO_3	pH
FBC-1	7/91	468	NA	NA	445	NA	85.9	56.1	0.44	13.8	1.53	464	72.8	15.3	0.0	0.0
FBC-1	10/92	Dry														

(a) Acidity as $CaCO_3$.
(b) Hardness as $CaCO_3$.
(c) Alkalinity as $CaCO_3$.
NA = Not analyzed.

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indicating that they are unrelated to mining activities. Additionally, these anomalies do not correlate with fluctuations in flow rate and may be related to "sloughing events" mentioned by Danielson (1981). These "sloughing events" are the result of the continuous erosion of shale and mudstone by the springs which flow from the North Horn Formation at the head waters of Bear Creek (Danielson, 1981).

Iron concentrations in the streams vary widely through time at the three stream locations (LT-1, BC-1 and BC-2), possibly due to dissolution of iron-bearing cement in the Blackhawk Formation. Iron concentrations have ranged from 0.03 to 98.9 mg/l during the period of record (1990 and 1991 Annual Reports) and proportionally correlate with TSS concentration.

Manganese concentrations in the permit area are low, ranging from below detection to 1.13 mg/l. High concentrations correlate with higher TSS concentrations (1990 and 1991 Annual Reports).

Changes in surface water quality from upstream (BC-1) to downstream (BC-2) of the Bear Canyon Mine during 1990 and 1991 were analyzed with a Student's t-test and the difference in the means of chemical concentrations were statistically insignificant (EarthFax Engineering, 1992, p. 2-6). This suggests that surface water quality does not change significantly as it flows past the mine. No comparison can be made for Trail Creek as the upstream monitoring point is consistently dry (1990 and 1991 Annual Report).

A comparison of surface water quality data (1991 Annual Report) with the national secondary drinking water standards indicates that the chemical quality of local surface water is typically within drinking water standards. No primary drinking water analytes were included in the surface water analysis suite.

Exceedances of secondary drinking water standards were found (iron, 4 out of 19 samples; manganese, 1 out of 19 samples; sulfate 1 out of 10 samples; and TDS, 3 out of

19 samples), however, these exceedances are typical of Bear Creek and other steams in the area prior to mining (Danielson, 1981). The sulfate exceedance (BC-1, February 28, 1991) is questionable in that BC-1 and BC-2 analyses are very similar in all other parameters. Yet, the sulfate analytical results differ for these two samples by two orders of magnitude. There were no exceedances of the secondary drinking water standards found in the analytical results for water collected at the NPDES mine water discharge point.

3.2 POTENTIAL SURFACE WATER IMPACTS

The potential surface water impacts that could result from mining and reclamation operations at the Bear Canyon Mine include:

- o Contamination from acid- or toxic-forming materials;
- o Increased sediment yield from disturbed areas;
- o Flooding or stream flow alteration;
- o Impacts to the chemical quality of surface water; and
- o Impact to surface water quantity.

3.2.1 Potential Contamination from Acid- or Toxic-Forming Materials

As noted in Section 2.2.1 of this PHC, no poor or unacceptable (acid- or toxic-forming) materials have been found in the permit area. The small, highly localized sulfur-bearing mineral zone discussed in Section 2.2.1 produced no acid- or toxic-forming waste rock. Historically,alkalinity of the mine water ranges from 141 to 314 mg/l and acidity ranges from 0 to 7 mg/l (Chapter 7 of this M&RP, 1990 Annual Report, and 1991 Annual Report). Due to the naturally alkaline character of the ground and surface waters in the area and the lack of acid- or toxic- forming materials, the probability of an impact from acid-and toxic-forming materials is minimal. However, if any of these materials are discovered in the future through the on-going mine plan, these materials will be disposed of within the guidelines set down in R645-301-731.300 and in Chapter 3 of the M&RP.

3.2.2 Potential Increase in Sediment Yield

Mining activities may result in an increase in sediment yield downstream of the disturbed areas. Sedimentation control measures (such as sedimentation ponds, diversions, etc.) have been installed to minimize this impact. These facilities are regularly inspected (see Chapter 7 of this M&RP) and maintained.

Current monitoring (10/17/91) indicates that no significant increase of TSS concentrations occurs from BC-1 (9 mg/l), upstream of the mine discharge, to BC-2 (5 mg/l), downstream of the mine discharge. Although TSS concentrations vary greatly at these two sample points, the relationship is typically that of higher TSS concentration upstream of the mine discharge and lower TSS concentrations below the mine discharge (1990 and 1991 Annual Report). Thus, control measures at the mine are effective at controlling sediment yields before discharging to the surface water. As a result of ongoing inspection and maintenance of the sediment-control facilities, there is a very low probability that sediment yield will increase due to mining activities.

3.2.3 Potential for Flooding or Stream Flow Alteration

Runoff from all disturbed areas flows through sedimentation ponds or other sediment-control facilities prior to discharge to adjacent undisturbed drainages. Three factors indicate that these sediment-control facilities minimize or preclude flooding impacts to downstream areas as a result of mining operations:

1. The sediment-control facilities have been designed and constructed to be geotechnically stable. Thus, the potential is minimized for breaches of the sediment-control devices to occur that could cause downstream flooding.

2. The flow routing that occurs through these sediment-control devices reduces peak flows from the disturbed areas. This precludes flooding impacts to downstream areas.

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3. By retaining sediment on site in the sediment-control devices, elevations of stream channels downstream from the disturbed areas are not artificially raised. Thus, the hydraulic capacity of the stream channels is not altered.

Following reclamation, stream channels will be returned to as close to their original configuration as possible (see Chapter 7 of this M&RP). The reclamation channels have been designed to safely pass the peak flow resulting from the 100-year, 6-hour storm in Bear Canyon and the 10-year, 6-hour storm in the ephemeral side drainages. Thus, potential for flooding of the reclaimed areas will be minimized. Interim sediment-control measures and maintenance of reclaimed areas during the post-mining period will prevent deposition of significant amounts of sediment in downstream channels following reclamation, thus maintaining the hydraulic capacity of the channels and preventing adverse flooding impacts.

The mine has been designed to prevent subsidence beneath perennial streams identified in Chapter 3 of this M&RP. Thus, no alteration of perennial stream flow patterns is anticipated.

Subsidence will occur in areas occupied by ephemeral stream channels. Although surface cracks that result from subsidence in the permit area tend to heal with time (DeGraff, 1978), ephemeral stream flows may be partially intercepted prior to completion of the healing process. In addition, the broad depressions created by subsidence may locally retain runoff that would normally discharge from an area. However, the following factors indicate that the impact of subsidence on ephemeral stream flow will be minimal:

1. Ephemeral stream flow in the area is sporadic, allowing significant periods of time for surface cracks to heal between flow events. As the cracks heal, the potential for interception of stream flow is minimized.

2. Ephemeral stream flow typically carries a high sediment load. This sediment will fill remaining cracks, thus accelerating the healing process and minimizing stream flow interception. Additionally, alluvial and colluvial deposits in the stream channels are unconsolidated and will assist in filling subsidence cracks that may occur.

3. The depressions created by subsidence are generally broad and changes in slope are not of sufficient magnitude to cause ponding. This is especially true in the steep terrain typical of the permit and adjacent areas.

The overburden thickness within the present permit area is 0 to 1500 feet. (Plate 7-4 of this M&RP). Maximum recorded cumulative subsidence within the permit area is 0.31 feet. Subsidence features in the area are associated with the coal outcrop (1991 Annual Report and Plate 3-3 of this M&RP). Within proposed Federal Lease U-024316 the thickness of overburden is 1000 to 1800 feet and no coal outcrops occur (Plate 7-4 of this M&RP). The effects of subsidence diminish with increased overburden thickness (Hustrulid, 1980). Thus, subsidence is not expected to impact stream flow patterns within proposed Federal Lease U-024316. Additionally, there will not be any surface facilities or portals in the proposed federal lease (Co-Op Mining Company, 1992a); thus, no disturbed areas will be created.

3.2.4 Potential Chemical Quality Impacts

Potential impacts to the chemical quality of surface water in the permit and adjacent areas include:

- Increased acidity, total suspended solids, and total dissolved solids;
- Contamination from hydrocarbon usage;
- Contamination from rock dust usage;
- Contamination from road salt; and
- Contamination from coal haulage.

<u>Acidity, Total Suspended Solids, and Total Dissolved Solids Impact.</u> As indicated in Sections 3.2.1 and 2.2.1 of this PHC, no significant impacts are expected to occur to the acidity of surface water in the permit and adjacent areas as a result of Co-Op mining and reclamation operations. Likewise, no significant impacts are expected to occur to TSS concentrations in the permit and adjacent areas (see Sections 3.2.2 and 3.2.3 of this PHC).

Historic TDS concentrations downstream of the mine water discharge point are generally lower than those found upstream. Average quarterly TDS concentrations for BC-1 and BC-2 measured during 1991 were 783 and 793 mg/l, respectively. The 10 mg/l difference in means was determined statistically insignificant through application of a Student's t-test (EarthFax Engineering, 1992 p. 2-6). The average TDS concentration measured during 1991 at the NPDES discharge point is 371 mg/l, which is significantly less than either Bear Creek average TDS concentration (1991 Annual Report). These data indicate that mine water does not decrease the quality of the surface water in the area.

Subsidence due to mining within proposed Federal Lease U-024316 is not expected to impact stream flow and no disturbed areas will be created within the lease due to mining activities (Section 3.2.3). Thus, impact to TDS concentrations is not expected to occur due to mining in this lease area.

<u>Hydrocarbon Usage Impact.</u> The potential impacts of hydrocarbon usage are contamination of soils and surface water resulting from spillage of hydrocarbon based products during maintenance of equipment or from tank leakage due to rupture of the tank. These potential impacts are presently being prevented and mitigated through the Co-Op Mining Company SPCC Plan (1992). These mitigations have been discussed in greater detail in Section 2.2.3 of this PHC. As a result of the implementation of this SPCC plan, the probability of spills and leaks of hydrocarbons contaminating the soil or surface water is low.

<u>Rock Dust Usage Impact.</u> The use of gypsum rock dust for the suppression of coal dust in the mine may potentially increase the sulfate and TDS concentrations of the water flowing into the mine. Mine water which has become enriched in the rock dust constituents will increase the concentrations of those constituents in surface water when discharged. Until recently, Co-Op Mining Company used a non-gypsum rock dust. In 1990, use of gypsum rock dust began.

During January and March, 1992, TDS concentrations of discharged mine water exceeded the NPDES Permit guidelines. Gypsum used in rock dusting is considered to have contributed to the high TDS concentrations. Co-Op Mining Company no longer uses gypsum dust in the Bear Canyon Mine (Co-Op Mining Company, 1992c). Due to the relative dryness of the mine, no future increase in TDS or sulfate concentrations in the mine discharge water is expected.

Road Salting Impact. Co-Op Mining Company utilizes salt to maintain the roads within the permit area in the winter. Road salt could contaminate the surface water if sufficient amounts of salt were washed into the creeks.

Co-Op Mining Company salts 2,100 feet of road (4,200 feet including the proposed Tank Seam access road) in the winter. The potential for impact to the surface water is low and not likely to occur for the following reasons:

1. 7,255 feet of road (including the Tank Seam access road) lie with the sediment control area.
2. Salt is stored by Emery County outside the permit area.
3. Mild winters have minimized the need for road salt.

Coal Haulage Impact. Coal is presently hauled from the loadout facility by independent trucking firms. Surface water could be impacted by coal spills that would either fall directly into Bear Creek or be washed down into the creek during a storm event. These spills could occur due to a vehicle accident involving a coal truck, or through failure to close the coal hoppers on the truck.

No vehicle accidents have occurred in which coal has been spilled and no coal spills have occurred outside of the sediment control area. All coal spills that have occurred have been due to failure to close the hoppers on the trucks. These spills were quickly and thoroughly cleaned (Co-Op Mining Company, 1992a). Thus, the impact of spills related to coal haulage is low, and the likelihood of occurrence is low also.

In addition to spills, wind may carry coal dust or small pieces of coal from the open top of the coal truck into creeks near the road. The potential impact from fugitive coal dust is presumed to be insignificant due to the small amounts lost during haulage in the permit and adjacent areas.

3.2.5 Potential Surface Water Quantity Impacts

Surface water availability may possibly be diminished through subsidence due to the pulling of pillars. Surface water availability is increased in Bear Creek due to mine-water discharges.

There is no evidence of surface water loss or diminishment related to subsidence at the Bear Canyon Mine (Chapter 3 of the M&RP). When subsidence occurs in the Wasatch Plateau area, the cracks seal rapidly (DeGraff, 1978), preventing the deep percolation and subsequent loss of water previously destined for springs and other water sources. Therefore, the probability of surface water availability being affected by the subsidence is low (see also Section 3.2.3 of this PHC). Subsidence is adequately monitored under the subsidence monitoring plan (Chapter 7 of this M&RP).

The effects of subsidence within the proposed Federal Lease U-024316 are expected to be less than those experienced within the present permit area due to the greater thickness of overburden and lack of coal outcrops (Section 3.2.3). Thus, impact to surface water availability is expected to be less than that experienced in the present permit area.

4.0 CONCLUSIONS

The potential impacts of these mining operations upon the hydrologic balance are summarized in Table 4-1. All of the potential impacts of mining on the hydrologic balance are being properly monitored and mitigation plans have been implemented.

TABLE 4-1

Summary of Potential Impacts and Mitigations

Potential Impact	Potential Effect	Potential Magnitude of Impact	Probability of Occurrence	Mitigation Measures
Leaching of acid- or toxic-forming materials	Degradation of surface and groundwater quality.	Low	Low	Monitoring, materials handled in approved manner.
Groundwater availability	Decrease in spring flow due to subsidence	Low	Low (no history of impact)	Monitoring
Groundwater availability	Interception of perched groundwater by mine workings	Low	High (ongoing)	Monitoring
Groundwater availability	Removal of water with coal	Low	High (ongoing)	Monitoring
Groundwater quality	Decrease in quality due to leaching of rock dust	Low	Low (Dryness of mine)	Monitoring, discontinued use of gypsum rock dust
Groundwater quality	Decrease in quality due to hydrocarbon usage	Low	Low	Monitoring, SPCC plan, inspections and maintenance
Sediment yield	Increase in TSS	Moderate	Low	Sedimentation ponds, diversions, interior sediments, control, monitoring
Flooding	Damage to downstream areas	Moderate	Low	Sedimentation ponds, diversion, monitoring
Stream flow alteration	Damage to streams due to subsidence	Low	Low	Protection of perennial streams, monitoring

TABLE 4-1 (Continued)

Summary of Potential Impacts and Mitigations

Potential Impact	Potential Effect	Potential Magnitude of Impact	Probability of Occurrence	Mitigation Measures
Groundwater quality	Decrease in quality due to road salting	Low	Low	Sedimentation ponds, monitoring, storing of salt off site by County
Surface water quality	Decrease in quality due to leaching of rock dust	Low	Low	Monitoring, discontinued use of gypsum rock dust
Surface water quality	Decrease in quality due to hydrocarbon usage	Low	Low	Monitoring, SPCC plan, inspections, maintenance
Surface water quality	Increase in TSS due to coal spills and wind blown coal dust	Low	Low	monitoring, sedimentation ponds
Surface water quality	Decrease in water quality due to road salting	Low	Moderate	Sedimentation ponds, monitoring
Surface water quality	Increase in flow of Bear Creek due to mine discharge	Low	High (ongoing)	Monitoring, underground. i.e., use of water

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BTCA Area F - **OUTSLOPE OF UPPER STORAGE PAD & DOWNCAST PILE.**

During construction of the Upper Storage Pad (Plate 7-1C) some fill was overcast down the face of the slope below. Also at the base of the cliff there is a pile of downcast material. The total area is approx 0.24 acres. The runoff volume for this area is calculated to be approx 0.03 acre ft.

Sediment and erosion control is presently maintained with the use of in-place erosion control matting and vegetation. With the extension of culvert C-8U in 1992, part of the drainage from the downcast pile will report to Sediment Pond A.

BTCA Area G - **PORTAL ACCESS ROAD SWITCH BACK**

This area covers a strip approx 25 ft wide by 160 ft long at the switchback of the portal access road. See Plate 7-1D. The runoff volume for this area is calculated to be less than 0.001 acre ft. The area is within AU-15.

Erosion and sediment control is performed by established vegetation.

<u>BTCA Area H</u> - TANK SEAM ACCESS ROAD CUT SLOPE ABOVE D-15U

This area, which is approx 0.028 acres (Plates 7-1C and 7-1E), includes the cut slope of the Tank Seam Access Road adjacent to ditch D-15U. The total flow from this area is 0.0035 acre-ft. The slope consists primarily of bedrock outcrop, minimizing the potential erosion on the slope. Areas where the slope demonstrates a high potential for erosion will be covered with erosion control matting, which will be maintained. Sediment and runoff will be controlled by a silt fence placed in ditch D-15U as shown on Plate 7-1C. Undisturbed drainage from area AU-3 and road drainage will also pass through the silt fence, with a maximum flow of 0.33 cfs. A typical silt fence installation is shown in Figure 7.2-15.

<u>BTCA Area I</u> - OUTSLOPE OF LOWER TANK SEAM ACCESS ROAD NEAR D-15U

This area, approx 0.048 acres (Plates 7-1C and 7-1E), includes the minimal amount of disturbed fill on the outslope of the lower Tank Seam Access Road across from D-15U and D-16U. The estimated volume of runoff from this area is 0.006 acre-ft, with a maximum slope length of 10 ft. Erosion will be controlled by the placement of erosion control matting on the slope, which will be maintained. To prevent excess water from crossing or saturating the fill, a berm will be maintained along the outer edge of the road, and the road sloped away from the fill material.

BTCA Area J - **LOWER TANK SEAM ACCESS ROAD CUT SLOPE ABOVE D-16U**

This area, which is approx 0.026 acres, includes the cut slope ajacent to ditch D-16U (Plate 7-1E). The total runoff volume from this area is estimated to be 0.003 acre-ft. The slope consists primarily of bedrock outcrop, minimizing the potential erosion on the slope. Areas where the slope demonstrates a high potential for erosion will be covered with erosion control matting, which will be maintained. Sediment and runoff will be controlled by the placement of a silt fence in ditch D-16U as shown on Plate 7-1E. Undisturbed drainage from area AU-2C and road drainage will also pass through the silt fence, with a maximum flow of 0.25 cfs. A typical silt fence installation is shown in Figure 7.2-15.

BTCA Area K - **OUTSLOPE OF FILL AREA AROUND C-16U**

This area is approx 0.23 acres, and includes the fill outslope of the lower Tank Seam Access Road around culvert C-16U (Plate 7-1E). The estimated volume of runoff from this area is 0.029 acre-ft, with a maximum slope length of 90 ft. Erosion and runoff will be controlled by the placement of erosion control matting on the slope, which will be maintained. To prevent excess water from crossing or saturating the fill slope, a berm will be maintained along the outer edge of the road, and the road will be sloped to drain water away from the slope.

BTCA Area L - **LOWER TANK SEAM ACCESS ROAD CUT SLOPE ABOVE D-17U**

This area, which is approx 0.019 acres, includes the cut slope ajacent to ditch D-17U (Plate 7-1E). The total runoff volume from this area is estimated to be 0.002 acre-ft. The slope consists primarily of bedrock outcrop, minimizing the potential erosion on the slope. Areas where the slope demonstrates a high potential for erosion will be covered with erosion control matting, which will be maintained. Sediment and runoff will be controlled by the placement of a silt fence in ditch D-17U as shown on Plate 7-1E. Undisturbed drainage from area AU-1B and road drainage will also pass through the silt fence, with a maximum flow of 0.43 cfs. A typical silt fence installation is shown in Figure 7.2-15.

BTCA Area M - **OUTSLOPE OF FILL AREA AROUND C-17U**

This area is approx 0.048 acres, and includes the fill outslope of the lower Tank Seam Access Road around culvert C-17U (Plate 7-1E). The estimated volume of runoff from this area is 0.006 acre-ft, with a maximum slope length of 50 ft. Erosion will be controlled by the placement of erosion control matting on the slope, which will be maintained. To prevent excess water from crossing or saturating into the slope, a berm will be maintained along the outer edge of the road above the slope and the road will be sloped to drain water away from the fill slope.

BTCA Area N - CUT AND FILL SLOPES IN AREA AU-1C

This area, which is approx 0.12 acres, includes the cut slope ajacent to ditch D-18U and the cut and fill slopes in the three switchbacks of the Tank Seam Access Road (Plate 7-1E). The total runoff volume from this area is estimated to be 0.015 acre-ft. The cut slopes consist primarily of bedrock outcrop, minimizing the potential erosion on the slope. Areas where the cut and fill slopes demonstrate a high potential for erosion will be covered with erosion control matting, which will be maintained. Sediment and runoff will be controlled by the placement of a silt fence in ditch D-18U as shown on Plate 7-1E. Undisturbed drainage from area AU-1A, AU-1C and road drainage will also pass through the silt fence, with a maximum flow of 0.65 cfs. A typical silt fence installation is shown in Figure 7.2-15. In order to prevent water from saturating or crossing the fill slopes, berms will be placed along the outside edge of the road and the road will be sloped to drain water away from the fill slopes.

BTCA Area O - OUTSLOPE BELOW FIRST TANK SEAM ROAD SWITCHBACK

This area is approx 0.04 acres, and includes the outslope of the first Tank Seam Access Road switchback (Plate 7-1E). The estimated volume of runoff from this area is 0.005 acre-ft, with a maximum slope length of 15 ft. Erosion will be controlled by the placement of erosion control matting on the slope, which will be maintained. To prevent water from crossing or saturating the slope, berms will be placed along the road, and the road sloped to drain water away from the fill slope.

BTCA Area P - **TANK SEAM ACCESS ROAD TOPSOIL STOCKPILE**

This area is approx 0.06 acres (Plate 7-1E). The estimated volume of runoff from this area is 0.008 acre-ft. Erosion and sediment will be controlled by a berm placed to totally contain runoff from the pile. The berm along the base of the pile (approx. 80 ft distance) will be a minimum of 2 ft high, with the ditch between the berm and topsoil pile a minimum of 2 ft bottom width, assuming 1H:1V side slopes. This will allow the berm to contain a volume of 0.011 acre-ft at the base of the pile, providing adequate protection for the topsoil.

BTCA Area Q - **UPPER TANK SEAM ACCESS ROAD CUT SLOPE ABOVE D-21U**

This area is approx 0.053 acres. It includes the cut slope ajacent to ditch D-21U (Plate 7-1E). The total runoff volume from this area is estimated to be 0.007 acre-ft. The slope consists primarily of bedrock outcrop, minimizing the potential erosion on the slope. Areas where the slope demonstrates a high potential for erosion will be covered with erosion control matting, which will be maintained. Sediment and runoff will be controlled by the placement of a silt fence in ditch D-21U as shown on Plate 7-1E. Undisturbed drainage from area AU-1A and road drainage will also pass through the silt fence, with a maximum flow of 0.14 cfs. Runoff will also pass through the silt fence adjacent to culvert C-17U prior to entering the natural drainage channels. A typical silt fence installation is shown in Figure 7.2-15.

BTCA Area R - **UPPER TANK SEAM ACCESS ROAD CUT SLOPE ABOVE D-22U**

This area is approx 0.06 acres. It includes the cut slope ajacent to ditch D-22U (Plate 7-1E). The total runoff volume from this area is estimated to be 0.008 acre-ft. The slope consists primarily of bedrock outcrop, minimizing the potential erosion on the slope. Areas where the slope demonstrates a high potential for erosion will be covered with erosion control matting, which will be maintained. Sediment and runoff will be controlled by the placement of a silt fence in ditch D-22U as shown on Plate 7-1E. Undisturbed drainage from area AU-1 and road drainage will also pass through the silt fence, with a maximum flow of 0.72 cfs. A typical silt fence installation is shown in Figure 7.2-15.

BTCA Area S - **OUTSLOPE OF FILL AREA AROUND C-23U**

This area is approx 0.07 acres, and includes the fill outslope of the upper Tank Seam Access Road around culverts C-22U, C-23U AND C-24U (Plate 7-1E). The estimated volume of runoff from this area is 0.009 acre-ft, with a maximum slope length of 35 ft. Erosion and runoff will be controlled by the placement of erosion control matting on the slope, which will be maintained. To prevent excess water from crossing or saturating the fill slope, a berm will be maintained along the outside edge of the road and the road will be sloped to drain water away from the fill slope.

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BTCA Area T - **UPPER TANK SEAM ACCESS ROAD CUT SLOPE ABOVE D-23U**

This area is approx 0.02 acres. It includes the cut slope ajacent to ditch D-23U (Plate 7-1E). The total runoff volume from this area is estimated to be 0.0025 acre-ft. The slope consists primarily of bedrock outcrop, minimizing the potential erosion on the slope. Areas where the slope demonstrates a high potential for erosion will be covered with erosion control matting, which will be maintained. Sediment and runoff will be controlled by the placement of a silt fence in ditch D-23U as shown on Plate 7-1E. Undisturbed drainage from area AU-2B and road drainage will also pass through the silt fence, with a maximum flow of 0.55 cfs. A typical silt fence installation is shown in Figure 7.2-15.

BTCA Area U - **TANK SEAM PORTAL PAD**

This area is approx 0.43 acres. It includes the Tank Seam portal pad and adjacent cut slope, as well as the area around the conveyor belt and borehole structure (Plate 7-1E). The total runoff volume from this area is estimated to be 0.05 acre-ft. Erosion and sediment will be controlled using silt fences placed in Ditch D-14D prior to the inlet of culvert C-12D and a silt fence placed below the belt and borehole structure prior to the outlet of C-12D (Plate 7-1E). A typical silt fence installation is shown in Figure 7.2-15.

RECLAIMED AREA BTCA

This section discusses the reclaimed areas for which runoff will be treated by alternate BTCA controls, rather than a sediment pond. Alternate controls will be used due to the remoteness of the disturbed area from the sediment ponds. The purpose of this BTCA control is to control runoff from the areas in order to minimize and reduce contribtutions of suspended solids, minimize erosion to the extent possible, and enhance stability of the reclaimed areas. Areas are delineated according to the type of BTCA treatment to be used, and are shown on Plates 3-2, Post-Mining Topography.

BTCA "1"

This area includes all of the disturbed area shown on Plate 3-2E, which is the affected area of the Tank Seam Access Road and Tank Seam Portal Pad. The BTCA control for BTCA "1" areas will be the use of erosion control matting, as described in Section 3.6.11. The matting will be maintained until revegetation efforts demonstrate that the vegetative cover is adequate to meet vegetative and runoff control requirements for bond release.

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APPENDIX 7-N

REVISED HYDROGEOLOGIC EVALUATION OF THE BEAR CANYON MINE PERMIT AND PROPOSED EXPANSION AREAS

CO-OP MINING COMPANY
Salt Lake City, Utah

Prepared By

EARTHFAX ENGINEERING, INC.
Midvale, Utah

April 26, 1993

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EXHIBIT D

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REVISED HYDROGEOLOGIC EVALUATION OF THE BEAR CANYON MINE PERMIT AND PROPOSED EXPANSION AREAS

1.0 INTRODUCTION

1.1 Scope

This report is an evaluation of the potential for operations at the Co-Op Mining Company Bear Canyon Mine to affect water quality and quantity at Birch and Big Bear Springs. The report also addresses revisions to the Bear Canyon permit area to allow incorporation of new Federal Coal leases U-024316 and U-024318, and the potential impacts that the lease expansions may have on the springs. This document is intended to supersede a previously-issued hydrogeologic evaluation report (EarthFax Engineering, 1991), which is herein updated and supplemented with additional hydrogeologic and water-quality data.

The work performed for this evaluation included:

1) A review of technical literature from the United States Geological Survey and the Utah Division of Water Resources, and permits on file with the Utah Division of Oil, Gas, and Mining.

2) Visits to the mine site to evaluate springs, collect historical spring flow data, tour accessible underground workings to evaluate groundwater inflow, and conduct preliminary water quality assessments (pH, temperature, and conductivity) of all accessible water sources.

3) A search of surface water and groundwater rights recorded with the Utah Division of Water Rights for the mine permit area and adjacent sections.

4) Discussions with Co-Op Mining representatives concerning historic groundwater inflows to the mine and the general operational history of the Bear Canyon mine.

5) Analysis of monthly precipitation, stream flow, spring flow, and geochemical data derived from monitoring stations in the vicinity of the Bear Canyon Mine.

6) Incremental drilling and aquifer testing of three borings from the mine floor to the Mancos Shale, and completion of the borings as monitoring wells.

7) Installation of dedicated purging and sampling systems in the monitoring wells, and collection of groundwater quality samples.

This report is divided into six sections, including this introduction. Section 2.0 is a description of area hydrogeology, Section 3.0 is a description of monitoring well installation and groundwater sampling, and aquifer testing is summarized in Section 4.0. Conclusions and recommendations are presented in Section 5.0, and references are contained in Section 6.0.

1.2 Background Information

The Bear Canyon Mine is located near the eastern margin of the Wasatch Plateau Coal Field in Bear Creek Canyon, a tributary to Huntington Creek Canyon (Figure 1-1). The mine is located approximately 9.5 miles west of Huntington, Utah.

Coal mining in the region of the study area began in the early 1900's. Mining operations have been or are presently being conducted by U.S. Fuel at Hiawatha, by Plateau Resources at Wattis, and by Co-Op Mining Company in the Trail Canyon and the Bear Creek Canyon. All of these operations have intersected the faults with which Big Bear and Birch Springs are associated, although the Co-Op Mining Company Trail Canyon and Bear Canyon operations are closest to the springs. The Trail Canyon Mine discontinued operations in late 1982 and has since been sealed; operations have been continuous at the Bear Canyon Mine since 1982.

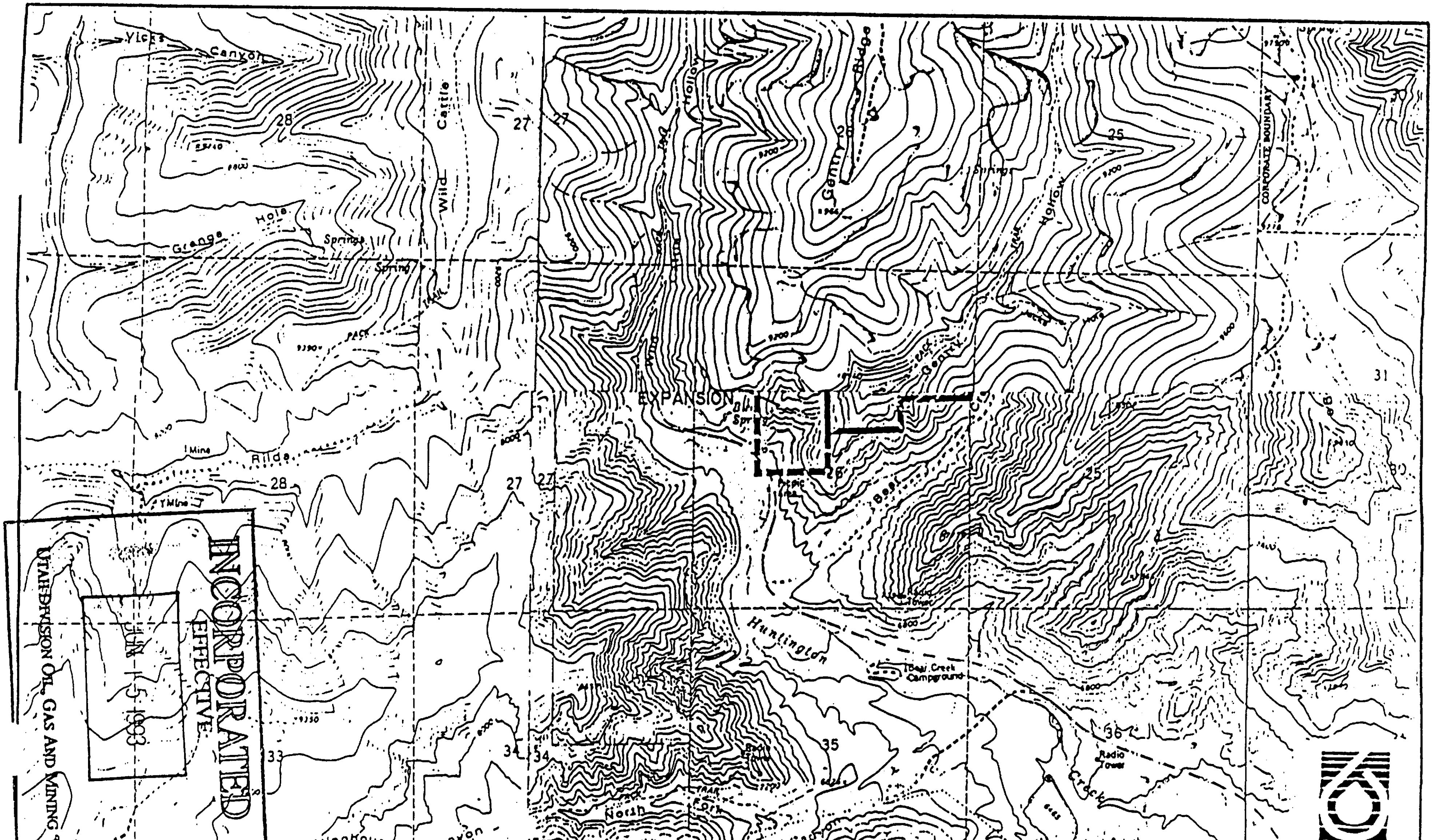


FIGURE 1-1. Location Map.

2.0 HYDROGEOLOGY

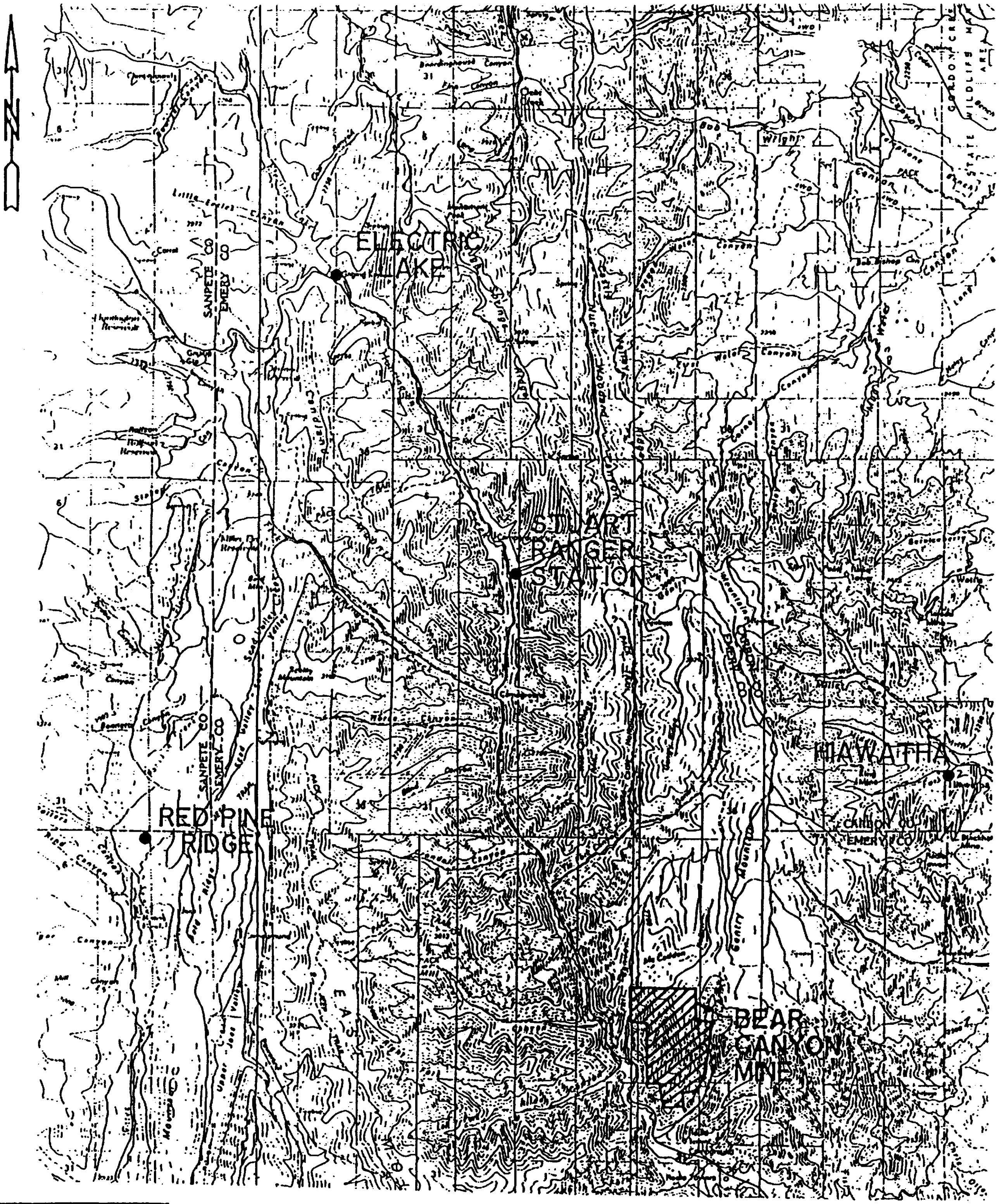
2.1 Climate

The Bear Canyon Mine permit and adjacent area (referenced herein as the study area) are located near the eastern margin of the Wasatch Plateau. Elevations within the study area range from approximately 6,500 to over 9,000 feet above sea level. This elevation range results in a significant variation in average annual precipitation amounts. At the higher elevations of the Wasatch Plateau, the average annual precipitation exceeds 40 inches.

Precipitation data has been collected at the Bear Canyon Mine since August 14, 1991. Because the period of Bear Canyon Mine precipitation records is short and because the data is collected at only one location, data from five surrounding precipitation recording stations were averaged to provide a more representative estimate of precipitation across the study area. The stations used in the averages are the NOAA weather stations at Hiawatha and Electric Lake and the SCS SNOWTEL stations at Stuart Ranger Station, Red Pine Ridge, and Cottonwood-Mammoth (Figure 2-1). The Bear Canyon Mine data, monthly precipitation data from each of the five stations and monthly five-station precipitation averages are presented in Appendix A.

2.2 Geology

2.2.1 General. Table 2-1 is a summary of stratigraphic relationships of the geologic units in the study area. The stratigraphic sequence of the lower Cretaceous-to-lower Tertiary section in the area suggests a regressive trend, from marine (Mancos Shale), through littoral and lagoonal (Blackhawk and Star Point Formations interbedded silt/mudstone and sandstone), to fluvial (Castlegate Sandstone, Price River Formation, and North Horn Formation sandstones and conglomerates), and lacustrine (Flagstaff Limestone) deposition.



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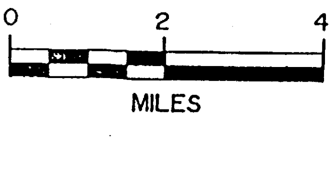

FIGURE 2-1. Location of Precipitation Monitoring Stations.

Table 2-1

Stratigraphic relationships, thicknesses, lithologies, and water-bearing characteristics of geologic units in the upper drainages of Huntington and Cottonwood Creeks (adapted from Stokes, 1964)

System	Series	Formations and members	Thickness (feet)	Lithology and water-bearing characteristics
Quaternary	Holocene and Pleistocene		0-100	Alluvium and colluvium; clay, silt, sand, gravel, and boulders; yields water to springs that may cease to flow in late summer.
Tertiary	Eocene and Paleocene	Flagstaff Limestone	10-300	Light-gray, dense, cherty, lacustrine limestone with some interbedded thin gray and green-gray shale; light-red or pink calcareous siltstone at base in some places; yields water to springs in upland areas. (See table 9.)
	Paleocene	North Horn Formation.	800±	Variegated shale and mudstone with interbeds of tan-to-gray sandstone; all of fluvial and lacustrine origin; yields water to springs. (See table 9.)
Cretaceous	Upper Cretaceous	Price River Formation	600-700	Gray-to-brown, fine-to-coarse, and conglomeratic fluvial sandstone with thin beds of gray shale; yields water to springs locally.
		Castlegate Sandstone	150-250	Tan-to-brown fluvial sandstone and conglomerate; forms cliffs in most exposures; yields water to springs locally.
		Blackhawk Formation	600-700	Tan-to-gray discontinuous sandstone and gray carbonaceous shales with coal beds; all of marginal marine and paludal origin; locally scour-and-fill deposits of fluvial sandstone within less permeable sediments; yields water to springs and coal mines, mainly where fractured or jointed.
		Star Point Sandstone	350-450	Light-gray, white, massive, and thin-bedded sandstone, grading downward from a massive cliff-forming unit at the top to thin interbedded sandstone and shale at the base; all of marginal marine and marine origin; yields water to springs and mines where fractured and jointed.
		Masuk Member Mancos Shale	600-800	Dark-gray marine shale with thin, discontinuous layers of gray limestone and sandstone; yields water to springs locally.

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Plate 1 depicts surface outcrops and geologic structures within the study area. Regionally, the strata in the study area dip to the south and southeast at an angle of two to three degrees (Brown, et al., 1987); this dip direction was confirmed by the stratigraphy observed during in-mine drilling conducted for this study, although dip angles determined from in-mine drilling ranged from 0.44 to 1.47 degrees. As shown on Plate 1, the Bear Canyon and Trail Canyon Mines are located in a complex graben bounded by the Pleasant Valley Fault (on the west) and the Bear Canyon Fault (on the east). Vertical displacements on both faults are approximately 100-150 feet. Brown, et al. (1987) describe a shattered zone within the graben, approximately two miles north of the current northernmost extent of the Bear Canyon Mine. In the portion of the graben within the permit area, only minor faulting (vertical displacements of 20 feet or less) has been identified, with the exception of the Blind Canyon fault (Plate 1), which is estimated to have approximately 220 feet of vertical displacement (down to the west) in the vicinity of the Bear Canyon Mine (Co-Op Mining Company, 1990a).

The major coal-bearing unit of the Wasatch Plateau Coal Field is the Blackhawk Formation. In the Bear Canyon mine, coal is removed from two seams within the Blackhawk Formation: the Blind Canyon seam is approximately 100 feet above the Blackhawk/Star Point contact and is continuous throughout the permit area; the Hiawatha seam thins and (in places) pinches out, and lies in direct contact with the Star Point Sandstone (Co-Op Mining Company, 1990a).

__2.2.2 Stratigraphy of In-Mine Drill Holes__. Descriptive logging and aquifer testing was conducted in three in-mine drill holes installed as part of this study. During the investigation, it was revealed that the Star Point Sandstone beneath the permit area is comprised of three separate sandstone units (in descending order: the Spring Canyon, Storrs, and Panther Tongues) interbedded with two mudstone units (inferred to be tongues of the Blue Gate member of the Mancos Shale). In this report, the mudstone tongue between the Spring Canyon and Storrs is termed the Mancos No. 1 mudstone, and that between the Storrs and the Panther is termed the Mancos No. 2 mudstone. A similar intertonguing of Blue Gate shale with the three Star Point sandstone units has been documented in the area of the Scofield

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S.W. and Scofield S.E. quadrangles, immediately north of the study area (Doelling, 1972). Characteristics of the three Star Point Sandstone aquifers are summarized in Section 2.5, and stratigraphic logs are contained in Appendix G.

2.3 Surface Water

2.3.1 Hydrology. Most of the study area is drained by two canyons, Trail Canyon (on the west) and Bear Canyon (on the east). Several smaller canyons drain the remaining southeast portion of Bear Canyon permit area. The Trail Canyon and Bear Canyon drainages contain intermittent streams, while the small drainages in the southeast portion of the permit area contain ephemeral streams. These streams discharge to Huntington Creek, the major drainage in the area.

The tributary streams primarily flow during the snowmelt period. From 65 to 80 percent of the annual discharge at the Huntington Creek gauging station (located near the Utah Power and Light diversion for the Deer Creek Power Plant) occurs during the snowmelt period from April through July (Danielson, et al., 1981). Flow records for the period from 1981 through 1983 and 1985 were obtained from Utah Power & Light. Data for the 1984 - 1985 water year are not available. Flow records for 1986 through September, 1991 were obtained from the U.S.G.S. Water Resources Division. Stream flow data are summarized in Appendix B.

2.3.2 Surface Water Quality. Danielson, et al. (1981) conducted surface water sampling of flows from selected streams in the study area. The waters sampled at the Huntington Creek gauging station were predominantly a calcium-bicarbonate water type. Waters sampled from the tributaries of Huntington Creek were predominantly a calcium-, magnesium-bicarbonate water type. During periods of low flow, the concentrations of sulfate in the tributaries were up to ten times greater than in Huntington Creek itself (Danielson, et al., 1981).

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Stream water monitoring points BC-1 (Upper Bear Creek) and BC-2 (Lower Bear Creek) were monitored for stream flow six and seven times, respectively, during the period from February through November, 1990 and average flow rates are presented in Table 2-2. During 1990 average flow rates increased by 12 gpm from BC-1 to BC-2. Water samples were collected from both BC-1 and BC-2 three and four times, respectively, during 1990 (Co-Op Mining Company, 1990b) and averages of these data are presented in Table 2-2. These averages were examined using a Student's t-test to test the hypothesis that the differences between the mean values for BC-1 and the mean values for BC-2 are insignificant. The t-test for difference in means is defined by the following formula:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sigma \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$$

where

$$\sigma = \sqrt{\frac{N_1 s_1^2 + N_2 s_2^2}{N_1 + N_2 - 2}}$$

with: N_1 and N_2 = number of samples from the two populations,
X_1 and X_2 = the means of the two populations,
s_1 and s_2 = the standard deviations of the two populations.

If the absolute calculated t value is less than the table t value, the difference in the means of the two data sets is considered insignificant (Spiegel, 1961). Table 2-3 presents the results of the statistical analysis. According to the Student's t-test, the means of the 1990 parameters for BC-1 and BC-2 displayed in Table 2-2 are not significantly different. Thus, the data suggest that there is no significant difference between the surface water collected upstream from the mine at BC-1 and the surface water collected downstream from the mine at BC-2.

Prior to 1991, all water inflows to the mine were used in mining operations, and no discharge was made to the surface. Increased mine water inflow as development continued to the north made it necessary to begin discharging to Bear Creek in 1991. During 1991, discharge rates increased from 60 gpm to 194 gpm (Co-Op Mining Company, 1991). Mine water discharge in 1992 has typically been 300 gpm (Co-Op Mining Company, 1992a).

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TABLE 2-2

Comparison of 1990 and 1991 Surface Water Monitoring
Results for BC-1 and BC-2

	BC-1		BC-2	
	1990	1991	1990	1991
Average Flow Rate (gpm)	32	27	44	100
Average pH	8.1	8.0	8.2	8.0
Average Specific Conductance (mmhos)	1392	971	1170	837
Average TSS (mg/l)	1770	623	1712	342
Average TDS (mg/l)	1361	783	1066	793
Average Fe (mg/l)	4.1	26.3	3.8	4.0
Average Oil & Grease (mg/l)	<5	<5	60	<5

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TABLE 2-3

Results of t-Test for BC-1 and BC-2, 1990

	BC-1		BC-2		Combined Statistics		
Parameter	Mean	Standard Deviation	Mean	Standard Deviation	σ	t (calc.)	Significant ?
Flow Rate (gpm)	32	17	44	22	21.59	0.99[a]	No
pH	8.1	0.08	8.2	0.16	0.14	1.25[a]	No
Specific Conductance (mmhos)	1392	1114	1170	772	934	0.42[a]	No
TSS (mg/l)	1770	2781	1712	2493	3100	0.02[b]	No
TDS (mg/l)	1361	1592	1066	1373	1740	0.22[b]	No
Fe (mg/l)	4.1	5.8	3.8	3.5	5.49	0.07[b]	No
Oil & Grease (mg/l)	<5	0.00	60	120	120	0.58[c]	No

[a] t (table) = 1.78 (Spiegel, 1961)
[b] t (table) = 1.94 (Spiegel, 1961)
[c] t (table) = 2.02 (Spiegel, 1961)

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During the period from May through October 1991, Bear Creek stream flow was measured seven times. Average stream flow increased from Upper Bear Creek (BC-1) to Lower Bear Creek (BC-2) by 73 gpm (Table 2-4), due to discharge from the Bear Canyon Mine. Surface water samples were collected quarterly from both BC-1 and BC-2. Utilizing the Student's t-test defined above, the 1991 data suggest that the one significant difference between the surface water collected at BC-1 and at BC-2 is the increase in flow rate due to mine water discharge from the NPDES discharge point (Table 2-4).

Flow rates above the mine water discharge, specific conductance, TSS, and TDS concentrations generally decreased from 1990 to 1991. Total precipitation measured at Red Pine Ridge and Mammoth-Cottonwood also decreased from 26.20 and 22.30 inches, respectively in 1990, to 13.20 and 6.00 inches respectively, in 1991 (Appendix A). The decrease in precipitation caused a decrease in both runoff and recharge to springs. In turn, the erosion of sediments due to runoff decreased and likely caused the decrease in chemical and sediment concentrations. During November 1990 and February 1991, chemical concentrations in both BC-1 and BC-2 increased to several times the concentrations detected throughout the balance of each respective year. The fact that this increase occurs both upstream and downstream of the mine suggests that it is not related to mining activities.

The mine water discharge typically has a pH of 7.9 and a specific conductance of 546 mmhos. The TDS and TSS concentrations average 371 and 13 mg/l, respectively. Iron concentrations are typically 0.11 mg/l and oil and grease are usually less than detection. These concentrations are generally less than the corresponding concentrations at both the upper and lower Bear Creek monitoring stations (Co-Op Mining Company, 1991). Thus, it is unlikely that the mine water discharge decreases the quality of water in Bear Creek.

Mine water collected in sumps in the mine is discharged to Bear Creek, and is monitored according to guidelines in NPDES Permit number U[illegible]. During the months

TABLE 2-4

Results of t-Test for BC-1 and BC-2, 1991

	BC-1		BC-2		Combined Statistics		
Parameter	Mean	Standard Deviation	Mean	Standard Deviation	σ	t (calc.)	Significant ?
Flow Rate (gpm)	27	9	100	78	60	2.30[a]	Yes
pH	8.0	0.10	8.0	0.10	0.01	0.00[a]	No
Specific Conductance (mmhos)	971	747	837	511	979	0.26[a]	No
TSS (mg/l)	623	913	342	299	784	0.50[b]	No
TDS (mg/l)	783	633	793	679	758	0.02[b]	No
Fe (mg/l)	26.3	49	4.1	4.7	40	0.79[b]	No
Oil & Grease (mg/l)	<5	0.00	<5	0.00	0.00	0.00[b]	No

[a] t (table) = 1.77 (Spiegel, 1961)
[b] t (table) = 1.90 (Spiegel, 1961)

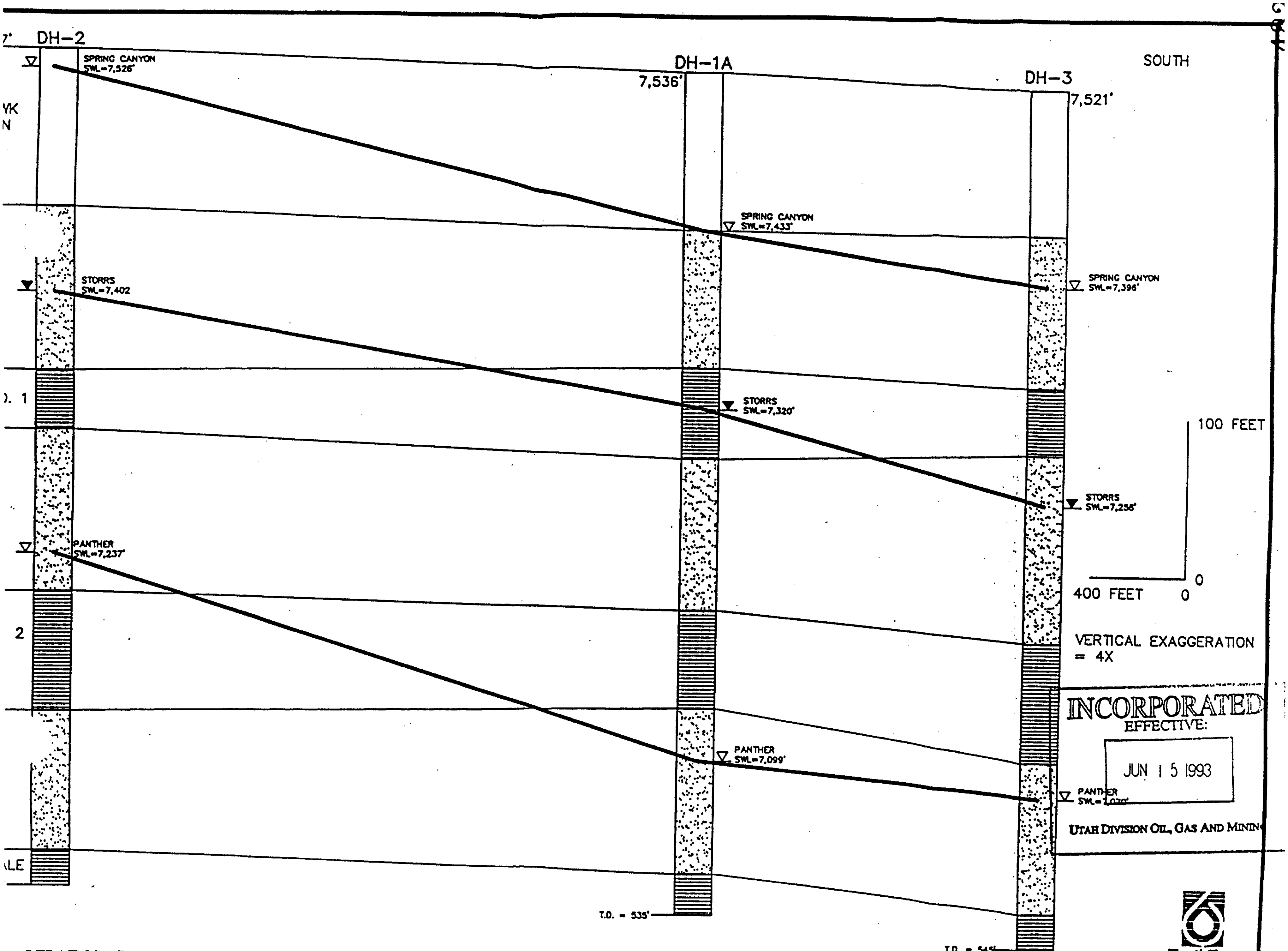
of January and March, 1992, TDS concentrations measured at the NPDES discharge point exceeded the maximum allowable concentration of 2,000 lbs./day. This increase was attributed to localized sulfur-bearing minerals in the mine's 3rd West section and the use of gypsum rock dust in the mine (Co-Op Mining Company, 1992a), which began in 1991 (Co-Op Mining Company, 1992b). This problem was corrected by using lime dust in the active sections of the mine. The 3rd West section is not presently active. Should mining resume in 3rd West, discharge from that part of the mine will be restricted (Co-Op Mining Company, 1992a).

2.4 Groundwater

The groundwater system in the study area has been investigated by Danielson, et al. (1981), Co-Op Mining Company (1986), and Montgomery (1991). The recharge, movement, and discharge of water within the groundwater system is dependent on climatic and geologic conditions in the study area. Although groundwater occurs in all of the geologic units listed in Table 2-1, none of the units are saturated everywhere (Danielson, et al., 1981).

<u>2.4.1 Occurrence of Groundwater</u>. The formations in the study area have been identified as having a combination of perched and regional water tables. In most of the study area, perched zones exist in the North Horn, Price River, Castlegate Sandstone and upper Blackhawk Formations.

Although a regional aquifer (termed the Star Point-Blackhawk Aquifer by Danielson, et al., 1981) has been proposed for the area, in-mine drilling and aquifer testing conducted for this study indicate that the three aquifers within the Star Point Sandstone have individual static water levels. Further, in the southernmost hole (DH-3) none of the three aquifers are fully saturated (Figure 2-2). The fact that the Star Point aquifers are separate and hydraulically distinct (a single water table does not transect the stratigraphic units as proposed



STRATIGRAPHIC AND HYDROLOGIC CROSS-SECTION THROUGH IN-MINE DRILLHOLES DH-1A, DH-2, AND DH-3 by Danielson, et.al. 1981) suggests that the "regional" aquifer in the study area is actually located below the Star Point/Mancos Shale contact.

2.4.2 Recharge. Snow at the higher elevations provides the greatest source of groundwater recharge. Deuterium analyses of groundwater in the region indicate that most, if not all, groundwater is derived from snowmelt (Danielson et al., 1981). The percentage of water derived from snowmelt which recharges the groundwater system versus that which runs off to stream flow is controlled by the surface relief, the permeability of exposed strata, the depth of snowpack, and the rate of snowmelt. The highest recharge occurs in areas of low surface relief and on formations which have high permeability from fractures and/or solution openings.

In the study area, the criteria which encourage recharge from snowmelt are typical of the areas of exposed North Horn and upper Price River Formations. The main recharge area to the groundwater system in the area of the Bear Canyon Mine is expected to be the shattered zone identified by Brown, et al. (1987) in Section 1, 2, and the north half of Section 11, in Township 16 South, Range 7 East (Plate 1). An additional area of recharge could also be expected in the southern half of Section 11 and the northern half of Section 14, due to the surface exposure of North Horn Formation (Plate 1), however, this area is not as highly fractured as the area to the north.

Outcrops within the permit area include the Price River Formation, Castlegate Sandstone, Blackhawk Formation, Star Point Sandstone, and the Mancos Shale. Danielson, et al. (1981) indicate that recharge to the Blackhawk-Star Point aquifer from direct infiltration of snowmelt to formations which outcrop below the North Horn Formation is small in comparison to recharge through low relief surfaces on the North Horn Formation. In the study area, low-relief exposures of formations below the North Horn Formation and above the coal outcrops is limited due to the steepness of the canyons. Therefore, the potential for recharge through these formations to the regional groundwater system within the permit area is limited.

Co-Op Mining Company has conducted spring and seep surveys of the permit and adjacent area and has identified three springs and two seeps which occur above the coal seam. These water sources are located in the northern part of the permit and adjacent area. As shown on the water rights map (Figure 2-3), no groundwater rights are found on the ridge overlying the Bear Canyon Mine. The only groundwater sources identified in the southern portion of the permit and adjacent area are Big Bear Spring and Birch Spring. These springs are located approximately 500 feet below the Blind Canyon seam mine floor, and issue from the contact between the Panther Tongue of the Star Point Sandstone and the Mancos Shale. The limited number of springs which occur in areas which overlie the mine is further indication that only limited recharge occurs in the Bear Canyon permit area.

2.4.3 Movement. The movement of groundwater in the study area is strongly controlled by faults and the dip of strata. Most of the water movement in the study area is through fractures, faults, and partings between the beds (Danielson, et al., 1981). According to Danielson, et al. (1981), a portion of the snowmelt recharge water is discharged close to the original recharge source, where the downward movement of water is impeded by impermeable beds of shale or mudstone. If lateral movement occurs close to the canyon edge, this movement continues until the land surface is encountered and discharge occurs as a perched spring. If the movement occurs on the interior of the mountain, the lateral movement continues until other vertically permeable lithologies or zones of fracturing are encountered.

Fracture-enhanced permeability allows water to pass vertically through strata which would normally impede flow. Depending on the extent to which the fractures are interconnected, vertical groundwater flow can be limited to a short distance, or it can extend to the regional water table (see Figure 2-4). Lines (1985) indicated that for the hydrogeologically similar area of Trail Mountain (south of the study area), despite a thick section of very low-permeability rock, some hydraulic connection exists between the perched aquifers and the proposed regional aquifer; such transfer occurs as downward unsaturated flow from perched aquifers to the regional aquifer along the fractures and faults.

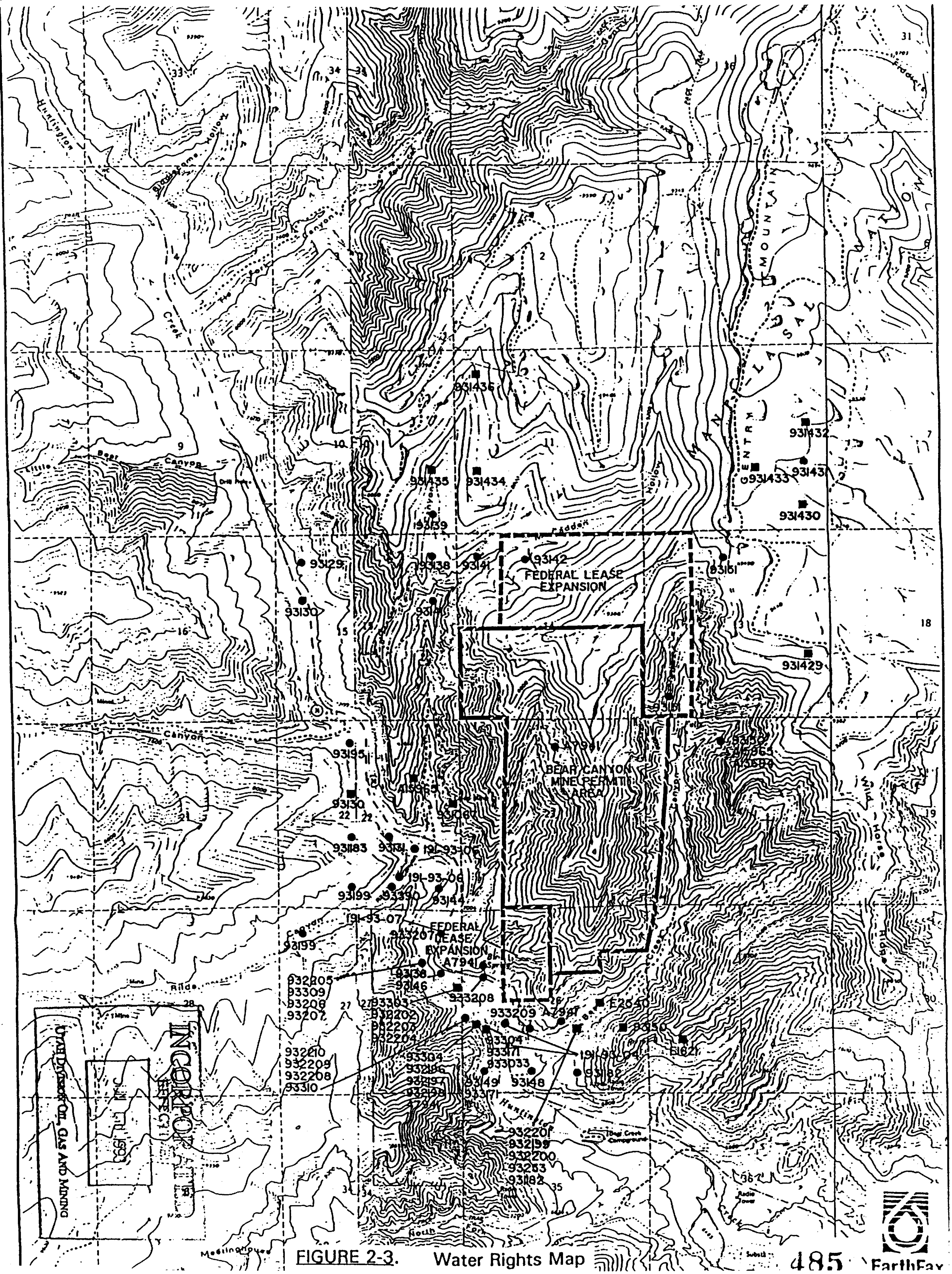


FIGURE 2-3. Water Rights Map

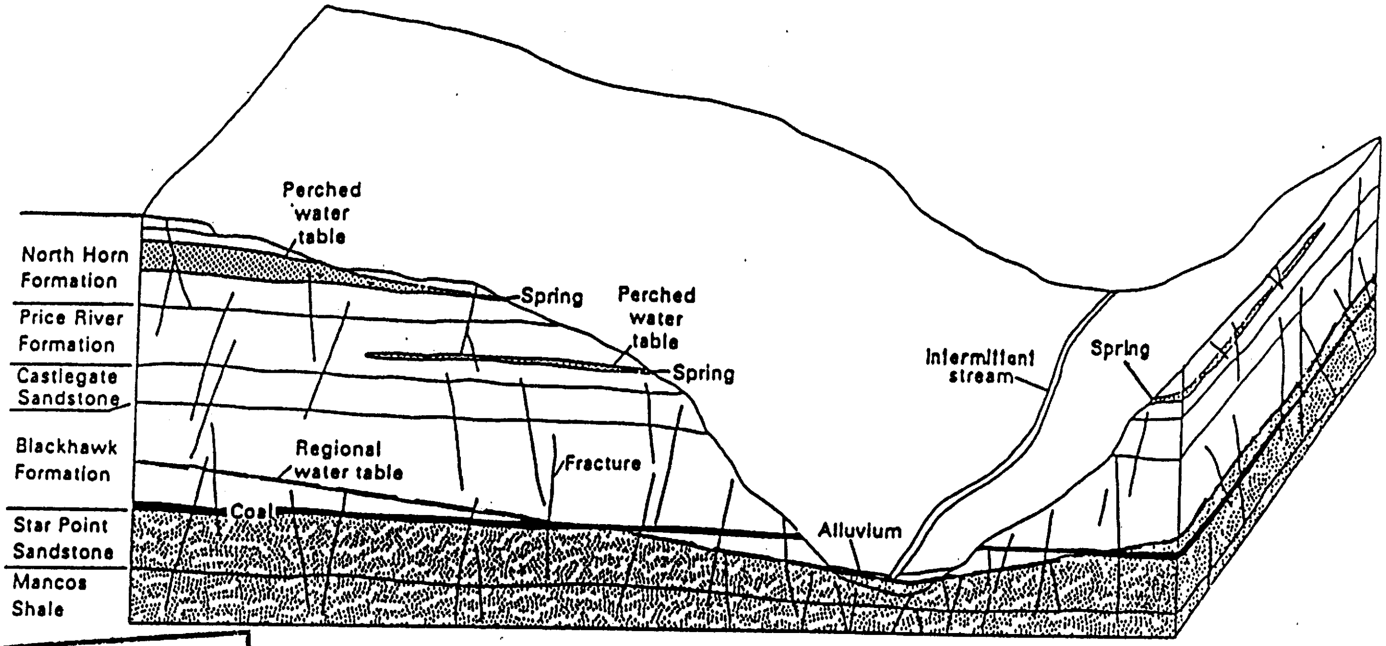


FIGURE 2-4. Generalized Block Diagram Showing Occurrence of Groundwater

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2.4.4 Discharge. Groundwater naturally discharges through springs, seeps, and by evapotranspiration. Some discharge from the groundwater system in the mine area may occur either by flow in the faults and fractures out of the Huntington Creek drainage or as subsurface flow to alluvial fill in the canyons, although such flow cannot be quantified. The major source of quantifiable discharge is springs. Within the area of the mine, two major springs have been identified: Big Bear Spring and Birch Spring. Two additional nearby springs (Tie Fork and Little Bear) have been identified outside the Bear Canyon Mine permit area. The locations of the springs are shown on Figure 2-5.

Big Bear Spring (maintained by the Castle Valley Special Services District) discharges from three prominent joints. Birch Spring (maintained by the North Emery Water Users Association) discharges from a normal fault which has approximately 20 feet of vertical displacement. Both springs issue from the lowest sandstone unit of the Star Point Sandstone (the Panther Tongue), where the Mancos Shale serves as a barrier to downward movement of groundwater (Montgomery, 1991). Tie Fork is not a true spring, but two flowing geophysical boreholes which have been developed by the Castle Valley Special Services District. Little Bear Spring issues from faults, and also is maintained by the Castle Valley Special Services District. Flow records for these springs have been obtained from the water companies and are presented in Appendix D. Big Bear Spring has an 12-year period of record (1981 to present), Birch Spring has a 4-year period of record (1989 to present), Tie Fork has an 9-year period of record (1984 to the present), and Little Bear Spring has an 11-year period of record (1982 to the present).

2.4.5 Inflow to Mine. According to Wendell Owen, the Bear Canyon Mine had water inflow to the old abandoned workings prior to the start of operations by Co-Op Mining Company in 1982. During the development of the East Bleeder entries (Plate 7-10A), water was encountered in two small faults subsidiary to the Bear Canyon Fault. Within a short time of this interception, the inflow to the abandoned workings ceased. The rate of inflow to the East Bleeders during development was approximately that which previously had flowed to the abandoned workings.

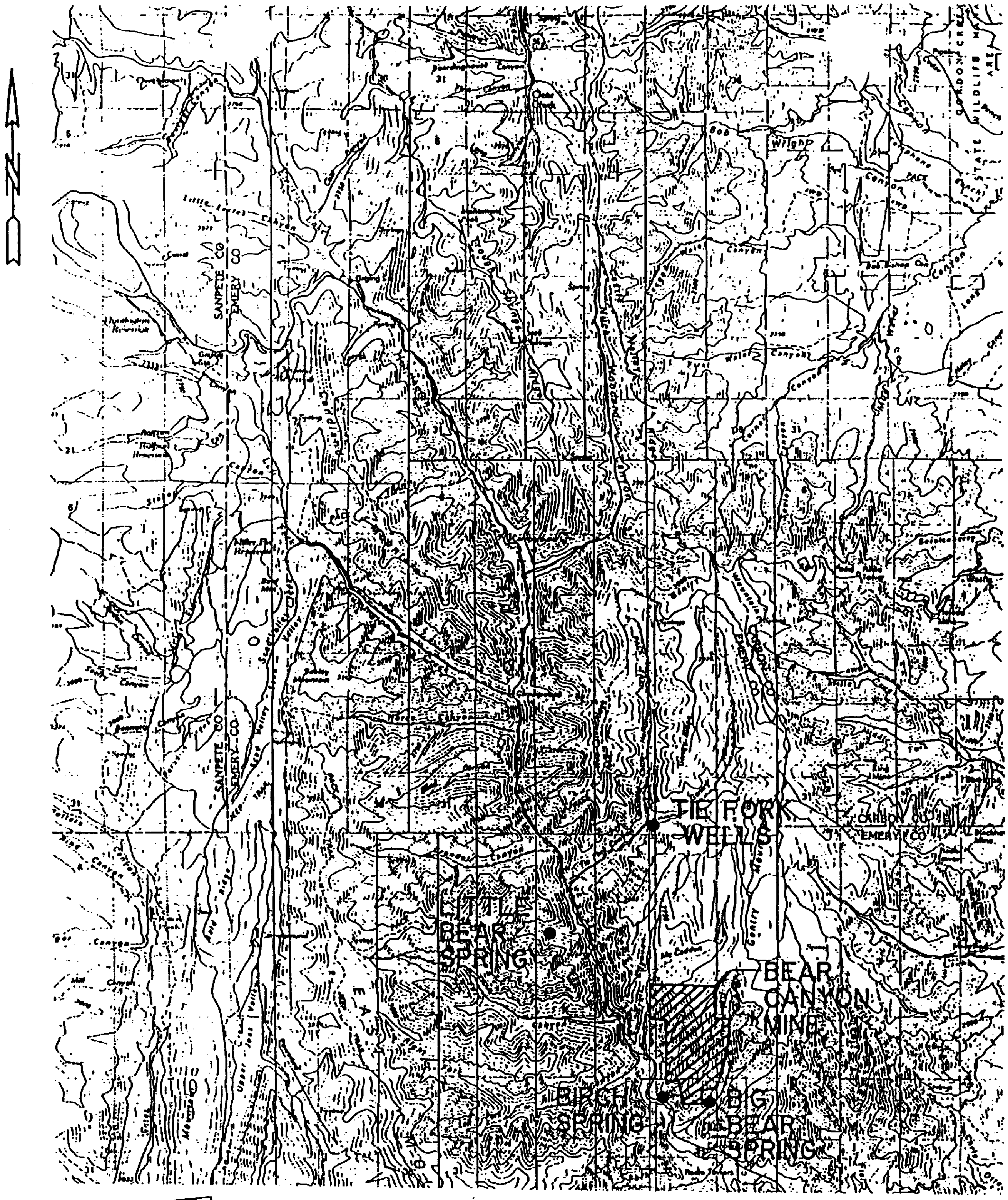

FIGURE 2-5. Locations of Springs in the Vicinity of the Mine Permit Area

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Inflow to the East Bleeders continued until the summer of 1989, when water was encountered as the North Main entries were advanced northward. According to Wendell Owen, inflow to the East Bleeders gradually diminished and flow into the North Mains was approximately 110 gpm. As the North Main entries were advanced, former zones of inflow several crosscuts back from the working face would drain, and the inflow rate would diminish and eventually cease. This observed coordination between upgradient inflow interception and downgradient inflow cessation as mine development advanced northward indicates a high degree of hydraulic interconnection through fractures in the portion of the Blackhawk Formation which overlies the mine, and that this fracture system directs flows to the southeast, along the dip of the beds.

The current major area of water inflow to the mine is located at the north end of the Second East entries (Plate 7-10A). Sumps located in the Second East and North Main entries in the area of the inflow are used to collect and store this water. Water from these sumps is pumped to the East Bleeder sumps, where a portion is diverted for in-mine use. The remainder of the water is pumped to the surface and discharged into Bear Creek (such discharges are recorded in the annual reports). A portion of the inflow to the area of the North Mains is used for culinary purposes at the mine.

Additional minor inflows to the mine consist of small quantities from diffuse sources throughout the mine. During the February 1991 underground tour, only one small roof dripper was found with sufficient flow (0.1 gallon per minute) to be sampled. Values of pH, temperature, and conductivity measured at the time of sampling are presented in Table 2-5. At the time of the underground tour, Wendell Owen indicated that several of the areas surveyed had previously been much wetter; however, only limited water inflows were found during the survey. This pattern is similar to that observed in other mines (e.g., Deer Creek, Plateau, and others) in the Wasatch Plateau (Danielson et al., 1981). In areas which do not intersect faults upon initial mining, moderate water inflows occur from diffuse sources (primarily from roof bolts). Flows from such sources are generally less than one gallon per

TABLE 2-5

Field Parameter Results

Sample I.D.	pH (Units)	Temperature (°C)	Conductivity (µmhos/cm)
Big Bear Overflow	6.9	10.9	460
Seepage Above Big Bear Spring	8.1	12.4	2000
Roof dripper in 3rd West Entries	7.7	14.2	510

minute. Typically, the roof bolt intersects and provides a drain for a localized perched aquifer,often a sandstone lens, which has a limited extent and limited quantity of water in storage. Once the stored water is drained (typically in one or two months), recharge to the perched zone is not sufficient to maintain the previous flow, and the inflow is reduced or ceases entirely.

Inflows in the north ends of the North Main and Second East entries are through roof bolt holes and hairline fractures which are presumed to drain overlying perched aquifers in the Blackhawk Formation. An indeterminate amount of water flows upward through the floor in the area of the Second East entries, and probably originates from the Spring Canyon Tongue aquifer (extrapolation of the Spring Canyon piezometric surface determined during testing of three in-mine monitoring wells indicates it would be approximately 15 feet above the mine floor in the north end of Second East).

Because mine inflow is from numerous and diverse sources, and because measurements prior to 1992 were not metered, the precision and accuracy of the flow rate measurements is considered by Co-Op to be insufficient to demonstrate that flow rates decrease over time when mine advancement is halted. Flow meters were installed in 1992 to allow more accurate and precise measurement of inflows, and continued periodic monitoring of inflow rates will provide more reliable data from which more definitive conclusions regarding the nature of the inflows may be drawn. Based on observations by Co-Op personnel, however, consistency of inflows in the north ends of the North Main and Second East entries is related to the rate at which the entries are advanced northward. When advancement is relatively constant and new fractures are encountered and drained, inflows are relatively constant. When the entries are not advanced, as the fractures are drained of their storage the inflow rate decreases (as was evident in 1992).

<u>2.4.6 Long-Term Impacts</u>. Springs in the vicinity of the Bear Canyon Mine issue from joints at the contact between the Panther Tongue and the Mancos Shale. Water inflows to the mine through bolt holes and fractures are from perched zones of limited storage.

Most of the inflow observed to migrate with northward mine advancement in the North Mains and northern Second East areas is presumed to be due to the interception of stored water in fractures which drain a more laterally continuous perched aquifer. This concept is further supported by the observation that inflows to the Third West Bleeders diminished and eventually ceased as the North Mains and Second East entries were advanced northward in 1989.

The absence of springs and the presence of efflorescence on sandstone outcrops in areas of seepage in the downgradient (southern) portions of the permit area suggests that groundwater movement potential in aquifers perched above the Bear Canyon seam is limited. Additionally, the absence of spring flows from the strata above the Panther Tongue/Mancos Shale contact and the presence of efflorescence on sandstone outcrops indicates a slow rate of groundwater movement and that most of the groundwater that reaches the outcrop evaporates on contact with the atmosphere. Further, no drainage through the mine floor in areas of known faults, or other evidence of hydraulic connection between such perched zones and the springs which issue from the Panther Tongue/Mancos Shale contact has been found. Thus, dewatering and diversion of inflows such as those discussed in Section 2.4.5 are not expected to affect nearby spring water quality or quantity in either the long- or short-term.

Potential negative impacts to spring water quality due to water leaking from the old workings and flowing over mudstones and into the spring collection system will not occur, because pumping into the old workings will not occur. To prevent inadvertent or accidental discharge into the old workings, a locked valve has been installed in front of the pressure relief valve shown on Plate 7-10a.

After mining and associated dewatering/diversion operations cease, the local piezometric surface will recover toward pre-mining conditions. Although inflows are expected to diminish and cease once the perched zones are drained, if inflows continue after mining is completed, the abandoned mine will not flood because the strata dip to the south-southeast; natural flow through the subsided entries and drainage to the surface will prevent accumulation (flooding) in the mine. As shown on maps of Bear (Blind) Canyon Seam structure and the 1990 water survey (Plates 6-4 and 7-10A, respectively, of the M&RP) mine inflows originating in the northern portions of the current mine and proposed expansion areas will be conveyed to the surface through the subsided entries and will ultimately discharge along the eastern limits of the mine, probably from the area of the present fan portal, which is the lowest-elevation coal outcrop in the lease area (7,440 feet).

Flooding of the old (pre-Co-Op) abandoned workings in the south end of the lease area and potential consequent impacts to water quality or quantity due to surface-flow contamination of springs 500 feet downslope from the coal outcrop will not occur; the lowest floor elevation of the sealed entries which lead into the old workings is 7,494 feet, or 54 feet above the elevation at the fan portal. Any post-abandonment inflow originating in the northern portions of the mine will be conveyed to the east, over the mine floor surface, well north of the old workings. Discharge from the fan portal will be conducted via culvert to channel RC-3 (Plate 7-7), which is designed to accommodate a 10-year, 6-hour flow of 3.77 cfs (1,700 gpm). The addition of a hypothetical 1.11 cfs (500 gpm) discharge from the mine would not require a change in channel design. Further, a hypothetical 2.22 cfs (1,000 gpm) discharge would require only that the channel riprap D_{50} be increased from 9 inches to 10 inches. Culvert sizing and other design details will be revised prior to mine reclamation, if required, when quantities and conditions are known. However, for current mine conditions, the reclamation plan is adequate to accommodate discharges in excess of those currently intercepted by the mine.

2.5 Summaries of Star Point Sandstone Aquifers

<u>2.5.1 Spring Canyon Tongue</u>. The Spring Canyon Tongue of the Star Point Sandstone is 88 feet thick at DH-1A, 103 feet thick at DH-2, and 98 feet thick at DH-3. It is generally light gray with minor dark minerals, but varies from dark gray to white. The grains range in size from fine to medium, and are moderately well sorted, subangular to subround, and cemented with calcium carbonate. The unit is generally moderately- to well-indurated.

Bedding is variable through the unit, from massive to laminated, with muddy zones and partings and locally dense bioturbation. The contact with the overlying Hiawatha coal seam of the Blackhawk Formation is abrupt; the lower contact with the Mancos No. 1 mudstone tongue is gradational.

The static water level measured in the Spring Canyon aquifer during drilling and testing was 3 feet below the top of the unit in DH-1A, 71 feet above the top of the unit in DH-2, and 25 feet below the top of the unit in DH-3. Thus, the Spring Canyon aquifer is confined by the Hiawatha coal seam in the northernmost drill hole (DH-2), and unconfined in the remaining two (DH-1A and DH-3).

2.5.2 Storrs Tongue. The Storrs Tongue is 96 feet thick at DH-1A, 105 feet thick at DH-2, and 120 feet thick at DH-3. It is generally light gray to dark gray, with minor dark minerals. The grains range in size from very fine to fine, and are moderately well sorted, subangular to subround, and well cemented with calcium carbonate. The unit is generally well-indurated. Bedding is variable through the unit, from massive to laminated, with muddy zones and partings and locally dense bioturbation, particularly in the lower portion of the unit. The contacts with the overlying Mancos No. 1 and underlying Mancos No. 2 mudstones are gradational. The Storrs Tongue sandstone is generally finer-grained, more dense, more highly indurated, and less permeable (as demonstrated by aquifer tests, Section 4.0) than the other two Star Point Sandstone aquifers.

The static water level measured in the Storrs aquifer during drilling and testing was 30 feet above the bottom contact of the confining Mancos No. 1 mudstone in DH-1A, 89 feet above the bottom of the Mancos No. 1 in DH-2, and 23 feet below the top of the unit in DH-3. The Storrs is unconfined by the Mancos No. 1 mudstone in only the most southern drill hole (DH-3).

2.5.3 Panther Tongue. The Panther Tongue is 105 feet thick at DH-1A, 88 feet thick at DH-2, and 97 feet thick at DH-3. It is generally light gray with minor dark minerals, but, like the Spring Canyon and Storrs tongues, varies from dark gray to white. The grains range in size from fine to coarse, and are poorly to moderately well sorted, round to subround, and poorly cemented with calcium carbonate. The unit is generally poorly to moderately-well indurated, and locally friable. Bedding is variable through the unit, from massive to laminated, with muddy partings and local bioturbation. The contact with the overlying Mancos No. 2 mudstone is gradational; the lower contact with the Mancos Shale is abrupt. The Panther Tongue sandstone is less dense, coarser-grained, less well cemented less indurated, and more permeable than the Spring Canyon and Storrs tongues.

The static water level measured in the Panther aquifer during drilling and testing was 33 feet below the top of the unit in DH-1A, 103 feet above the top of the unit in DH-2, and 27 feet below the top of the unit in DH-3. The Panther aquifer is confined by the Mancos No. 2 mudstone only in DH-2; unsaturated conditions exist in southern drill holes DH-1A and DH-3.

2.6 Groundwater Quality

Monitoring stations are sampled four times per year as a part of the Co-Op Coal Company hydrologic monitoring program (Plate 2). A summary of water-quality analyses for groundwater samples collected is presented in the Annual Hydrologic Monitoring Report (Co-Op Mining Company, 1991). Groundwater-quality samples are routinely collected in the permit and adjacent areas from the underground bleeders, monitoring wells, and springs associated with faults and joints in the Panther Tongue of the Star Point Sandstone.

The general character of the groundwater in the permit and adjacent areas is that of slightly alkaline calcium-bicarbonate water that contains low concentrations of total dissolved solids (TDS), nutrients, and metals. Field conductivity and pH range from 300 to 842 mg/l and from 6.1 to 8.1, respectively. TDS is typically 400 mg/l. Historically, acidity is zero and average alkalinity is 290 mg/l. Sulfate and magnesium concentrations are typically 70 and

40 mg/l, respectively. Iron and manganese concentrations are typically 0.3 and 0.1 mg/l, respectively.

Figure 2-6 presents a Piper diagram of average analytical results of the sampling events in 1991 for six groundwater monitoring points: Birch Spring (SBC-5, eight samples), North Mains (SBC-9, five samples), Ball Park Spring (BP-1, two samples), Big Bear Spring (SBC-4, eight samples), Co-Op Spring (CS-1, two samples), and Trail Canyon Spring (TS-1, two samples). The Piper diagram is divided into three fields: cations, anions, and the combined field. Values are in percent milliequivalents, and are plotted in the anion and cation fields and projected into a combined field. Spatial relationships that are repeated in all three fields are indicative of relationships between waters. The spatial relationships among the six waters differ from field to field. Birch Spring has the least similarity to the other waters. For example, Birch Spring water plots very close to mine water in the cation field, but it plots as an outlier in the anion field and in the combined field. This is due to a higher percentage of sulfate in Birch Spring water than in the mine water or the other spring water in the area. In fact, the mine water and BP-1 water have the lowest percentages of sulfate of the groundwater represented in the Piper diagram. Thus, the spatial relationships exhibited in the Piper diagram suggest that the mine water is of a higher quality than Birch Spring water. Furthermore, the difference in spatial relationships in the different fields suggests the waters are not hydraulically or chemically connected.

Figure 2-7 presents a series of Stiff diagrams which characterize waters from the same six groundwater monitoring points used in Figure 2-6. The six waters display a similar Stiff pattern, that of a calcium-bicarbonate water. Additionally, the Stiff patterns indicate that SBC-9 (North Mains) water has the lowest sulfate concentration (1.18 meq) and SBC-5 (Birch Spring) has the highest sulfate concentration (2.62 meq) of the groundwater sampled. SBC-4 (Big Bear Spring) water has a sulfate concentration of 1.36 meq. SBC-9 also has the lowest chloride value of the groundwaters sampled. This relationship between the sulfate and chloride concentrations does not suggest that the mine water could diminish the quality of the spring water in the area.

1-BIRCH SPRINGS
SBC-5

2-SBC-9

3-BP-1

4-BEAR SPRING
SBC-4

5-CS-1

6-TS-1

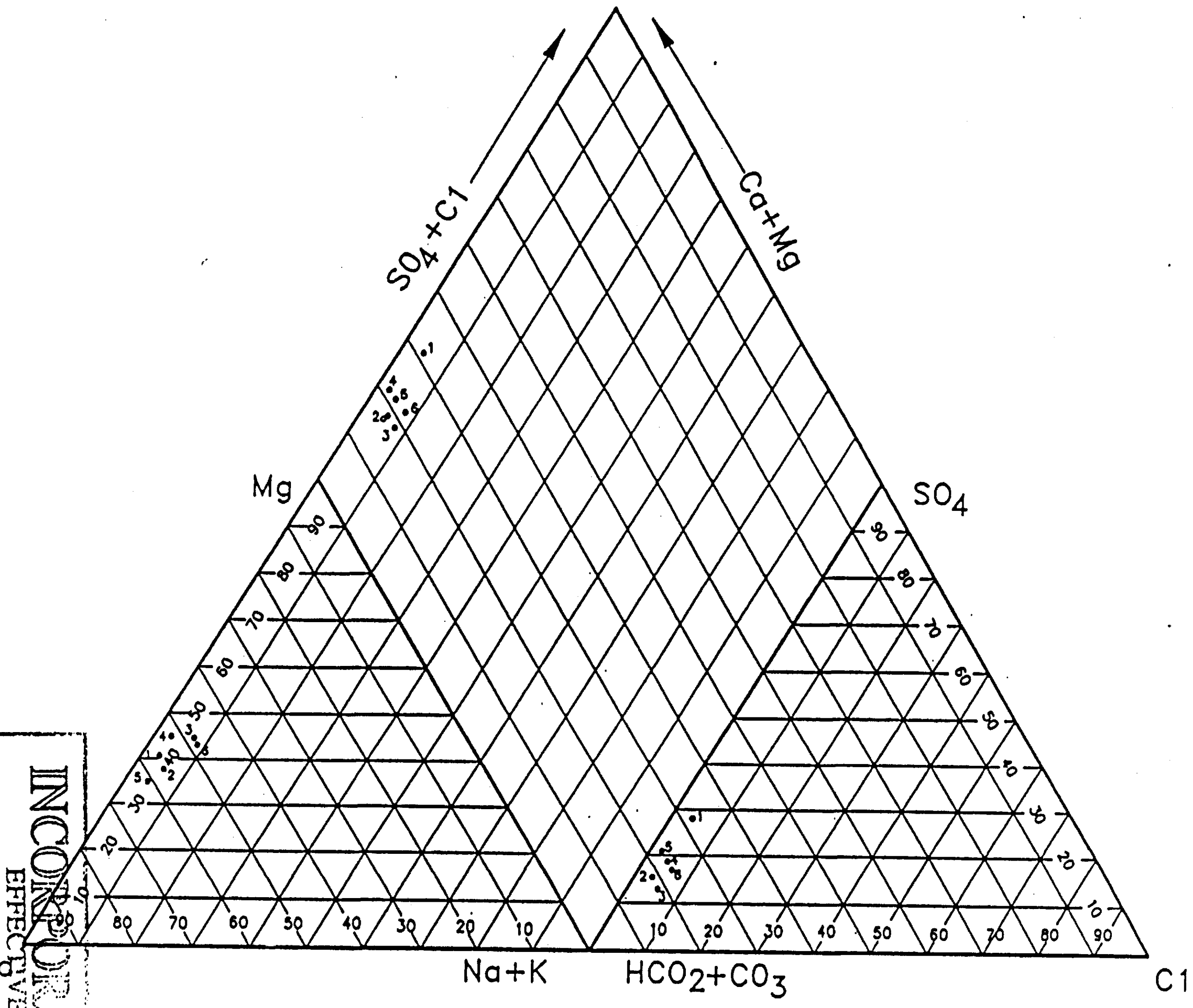

FIGURE 2-6. PIPER DIAGRAM OF AVERAGE GROUNDWATER ANALYTICAL RESULTS

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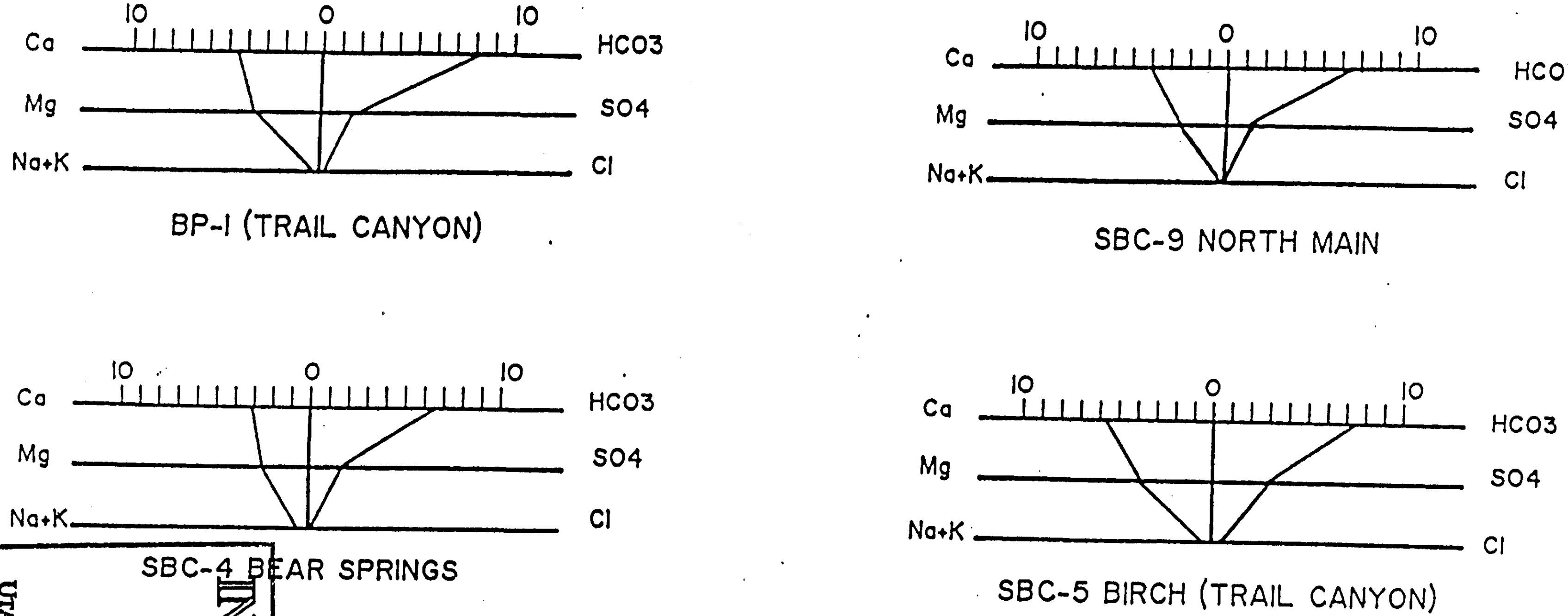

FIGURE 2-7. Stiff Diagrams of Spring Water Analytical Results

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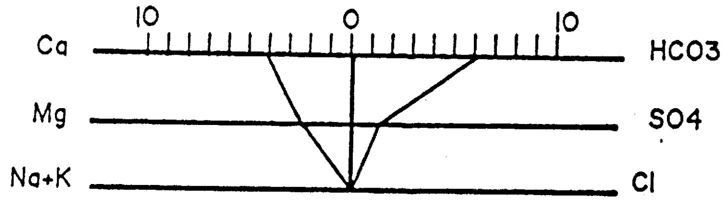
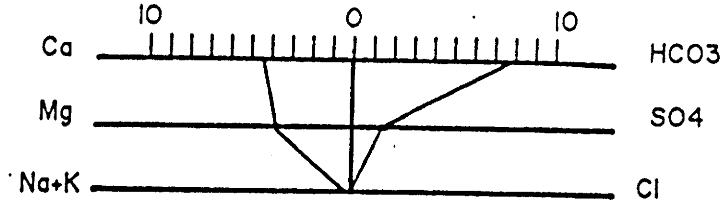


CS-1 CO-OP SPRING (TRAIL CANYON)



TS-1 TRAIL CANYON SPRING

FIGURE 2-7 (continued). Stiff Diagrams of Spring Water Analytical Results

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The major portion of water inflow to the mine is used within the mine or for culinary purposes by Co-Op Mining Company. According to the Co-Op Bear Canyon Mining and Reclamation Plan, the water which flows from Big Bear Spring (also called Huntington Spring)and Birch Spring is used by the Huntington community for culinary purposes (Co-Op Mining Company, 1985). Water collected in Trail Canyon from TS-1 (Trail Canyon Spring) is also used locally for culinary purposes. CS-1 (Co-Op Spring) was used in the past, but is no longer used for culinary purposes (Co-Op Mining Company, 1992a).

Wells in the permit and adjacent areas are either observation wells owned by Co-Op Mining, or exploration wells owned by Northwest Energy. Three new monitoring wells (DH-1A, DH-2, and DH-3, Plate 1) were drilled within the permit area for this study. DH-1A and DH-2 were drilled in late 1991 and DH-3 was drilled in early 1992. The three wells were completed in the Spring Canyon Tongue of the Star Point Sandstone, and were developed, tested, and sampled in May, 1992. The results of laboratory analyses of the monitoring well samples are summarized on Table 2-6, and complete analytical reports are presented in Appendix H.

Figure 2-8 presents Stiff diagrams of ions in groundwater from the in-mine wells. Waters from DH-1A and DH-3 have Stiff patterns similar to those of the calcium-bicarbonate spring water depicted on Figure 2-7. Water from DH-2 has a calcium, magnesium, sodium, potassium-sulfate pattern. This pattern is distinctly different from other groundwater that has been sampled in the permit and adjacent areas, and is presumed to be due to the dissolution of locally-occurring sulfate salts.

TABLE 2-6

Summary of Laboratory Analytical Results for Groundwater From In-Mine Monitoring Wells

ANALYTE (mg/l)	DH-1A	DH-2	DH-3
Aluminum	0.2	<0.1	<0.1
Arsenic	<0.05	<0.05	<0.05
Barium	0.071	0.127	0.129
Cadmium	<0.01	<0.01	<0.01
Calcium	38.9	51.9	50.9
Chromium	0.025	<0.01	<0.01
Copper	<0.01	<0.01	<0.01
Iron	0.505	0.280	0.220
Lead	<0.01	0.030	<0.01
Magnesium	20.1	29.5	28.9
Manganese	0.062	0.101	0.232
Mercury	<0.0005	<0.0005	<0.0005
Molybdenum	0.058	0.010	<0.01
Nickel	<0.01	<0.01	<0.01
Potassium	31.2	1.5	2.6
Selenium	<0.0005	<0.0005	<0.0005
Sodium	14.1	8.8	15.2
Zinc	<0.01	<0.01	<0.01
Oil & Grease	2.0[a]	<0.5	<0.5

[a] Oil and Grease expected (hydraulic fluid leak on rig).

TABLE 2-6 (Continued)

Summary of Laboratory Analytical Results
for Groundwater From In-Mine Monitoring Wells

ANALYTE (mg/l)	DH-1A	DH-2	DH-3
TDS	285	330	339
Hardness as CaCO3	162	321	307
Boron	<0.05	0.064	0.061
Alkalinity as CaCO3	94	285	294
Bicarbonate	110	340	336
Carbonate	2.3	3.5	11.5
Hydroxide	0	0	0
Chloride	4.9	4.2	4.2
Fluoride	0.28	0.18	0.16
Ammonia	<0.2	0.64	0.22
Nitrate	0.42	0.74	<0.5
Phosphate	0.129	0.25	0.027
Sulfate	128	33	38
Sulfide	<0.1	<0.1	<0.1

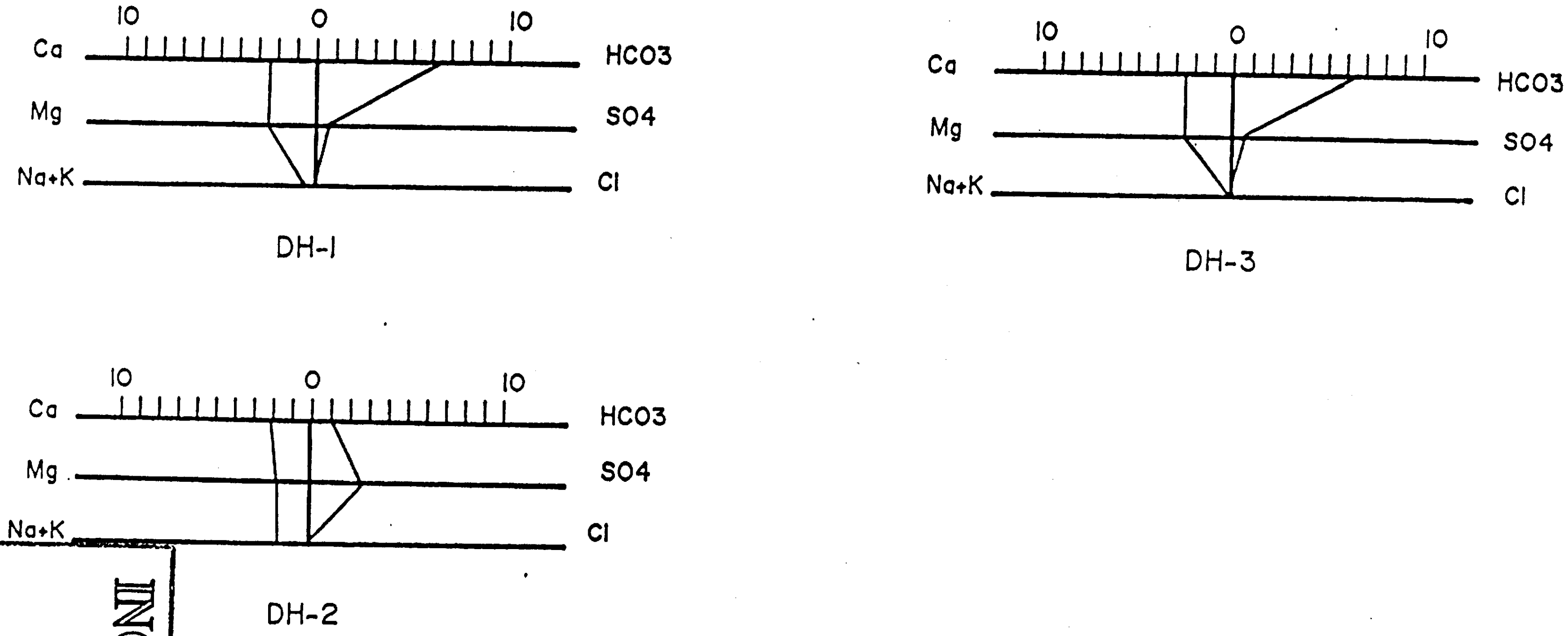

FIGURE 2-8. Stiff Diagrams of In-Mine Monitoring Well Analytical Results

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Groundwaters sampled from the in-mine wells have a TDS range of 285 to 339 mg/l. Dissolved iron and manganese concentrations range from 0.220 to 0.505 mg/l and from 0.062 to 0.232 mg/l, respectively.

2.7 Spring Flow

Big Bear and Birch Springs were visited on February 18 and 19, 1991, during a site survey to evaluate the geology of the spring locations and to collect samples of discharge water, if available. No surface flow occurred at the Birch Spring and the collection system was locked. At Big Bear Spring, a sample was taken from the spring overflow from the northernmost joint.

A second sample was taken from seepage flow which occurs on the slope above the Big Bear Spring. The seepage originates from the cliffs at the contact between the Star Point Sandstone and Blackhawk Formation, and occurs in two areas approximately 100 yards apart. Seepage in each area appears to occur directly from the formation contact, along approximately 100 to 150 feet of the outcrop. The flow is difficult to quantify, but it is concentrated at several bedrock ledges, and was estimated at the time of the site visit to be approximately 10 gallons per minute. The easternmost seep occurs at a location that is in shade most of the day, and considerable accumulations of ice where found at this seep, due to continual freezing of the discharge. The pH, temperature, and conductivity values for these samples are presented in Table 2-5.

As indicated on Table 2-5, the electrical conductivity of water within the mine is similar to that of water from Big Bear Spring. Water from seeps above the spring is considerably different, with a conductivity approximately four times that of the spring samples, presumably due to the dissolution of gypsum from mudstone in the area from which the seeps issue.

Monthly flows from the Big Bear, Birch, and Little Bear springs and the Tie Fork wells were analyzed. Little Bear Spring and the Tie Fork wells were included in the analysis because of their long periods of record and their proximity to the mine permit area. The spring flows were compared to five-station average monthly precipitation (see Appendix A) and stream flow for Huntington Creek gauging station above the Deer Creek Diversion (see Appendix B) plotted against time. These three plots were combined in a single graph to allow a direct comparison. For readability, the graph durations were limited to one year per sheet for each spring analyzed (an example is presented in Figure 2-9). All graphs are presented in Appendix E.

<u>2.7.1 Little Bear Spring</u>. Plots of flow from Little Bear Spring for the period of 1982 through 1985 show that the peak spring flows occur one month behind the peak stream flow in Huntington Creek. In 1986, the peaks occur in the same month, possibly indicating an early snowmelt. In 1987, the peak from Little Bear Spring was delayed by two months.

In the period from 1988 through 1990, no significant spring peak flow is evident. There was a gradual rise in the flow in the fall of 1988 and a gradual decline in early 1989. During 1991, peak spring flow occurred one month behind peak stream flow.

<u>2.7.2 Tie Fork Wells</u>. Flows from the Tie Fork wells show no seasonal variation, except for a period from July through November, 1988. By December, 1988 flows had returned to approximately the previous level and flows through 1991 have been essentially constant. This flow fluctuation corresponds to the flow increase in the Little Bear Spring, though the fluctuation of Little Bear was over a longer period.

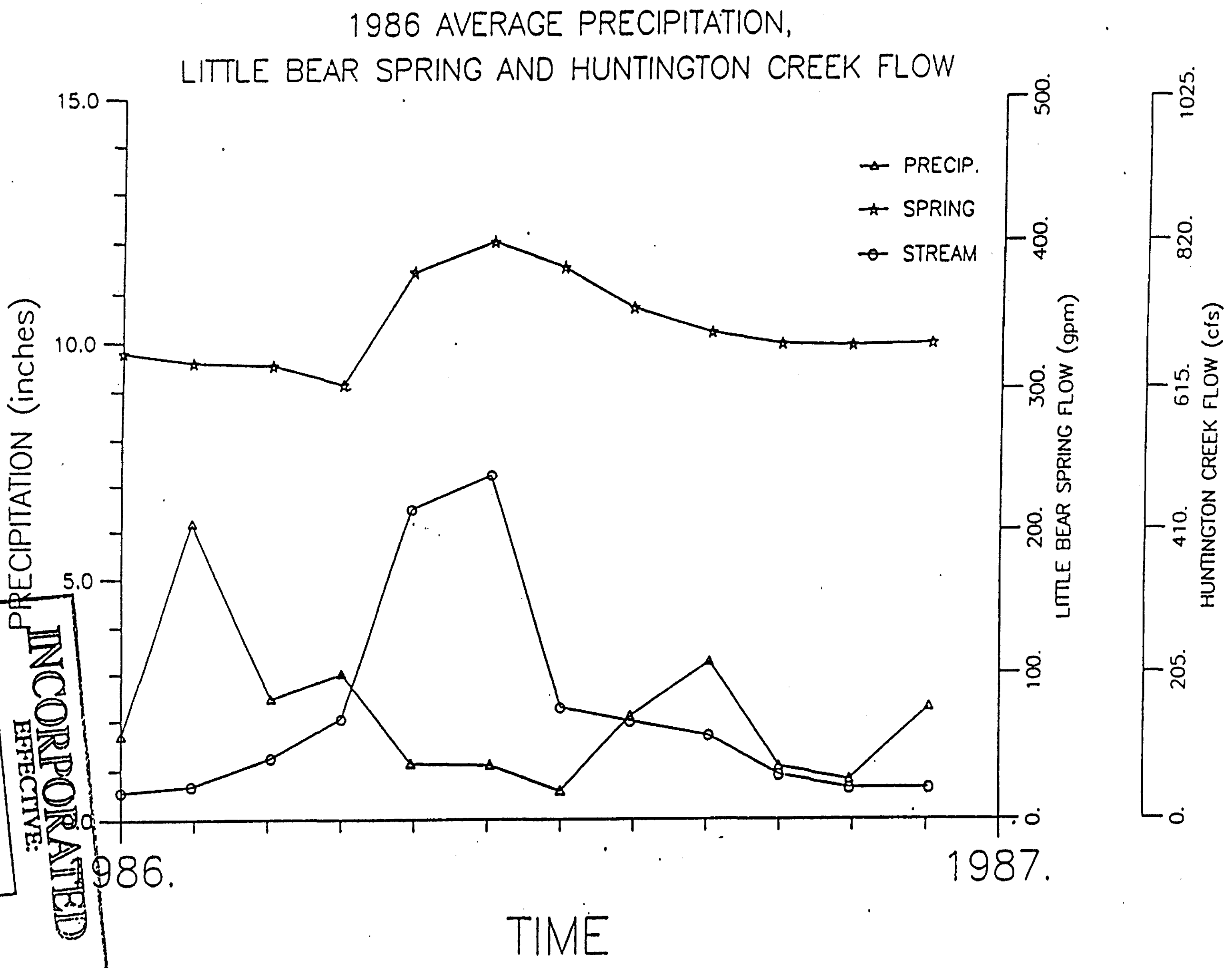

FIGURE 2-9. Example of Spring Flow Graph

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2.7.3 Big Bear Spring. Plots of flow from Big Bear Spring show that peak flows during the period of 1980 through 1986 occurred about one month later than peak flows at the Huntington gauging station (above the Deer Creek Mine access road). In the 1987-1988 water year, the lag period between peaks in the stream and spring discharge is approximately two months. This increase in lag time is due to a combination of lower precipitation accumulations (28.4 inches average annual precipitation 1980-1986 versus 19.75 inches 1987-1990, see Appendix A) and shorter snowmelt period.

Year-by-year comparisons of the flow recessions at Big Bear Spring for the years 1980 through 1986 show very similar patterns; the slope line of the spring flow decline and the base flow level for the spring are generally the same from year to year. This indicates that the snowmelt recharge is greater than the volume required to recharge the groundwater system storage, and that excess water is being discharged from the system as peak flows through the spring. It also suggests that no outside influence (i.e., mining) affected the groundwater system.

For the period from 1988 to 1991, no snowmelt peak can be identified on the flow spring flow graphs. Also, a comparison of spring flow from years 1987 through 1991 indicates a general decline in flow. This is inferred to be due to the small amount of precipitation during this period. The quantity of snowmelt recharge during these years was not sufficient to create either of the following conditions: 1) completely fill the depleted storage in the system, (resulting in a base flow lower than that of the previous year), or 2) provide a spring flush (although recharge may be sufficient to restore deleted storage).

Under the first condition, the groundwater system is being drained and a new base flow condition will eventually be established, provided precipitation inputs are stabilized. Once the groundwater system was stabilized, the second condition would prevail until the precipitation (and recharge) increased sufficiently to fill the excess storage capacity in the groundwater system. It appears that the first condition occurred at the Big Bear Spring during the period of 1987 through 1991.

2.7.4 Birch Spring. The Birch Spring flow increased by almost 300 percent for a three month period and a reduction in water quality in the fall of 1989 (North Emery Water Users Association, 1991). Table 2-7 is a summary of water quality data before, during, and after the anomalously high flow event, and shows that water quality returned to normal once flow rates normalized. The reason for this fluctuation is unknown. The event occurred shortly after the Bear Canyon mine intercepted an inflow of about 110 gpm in the North Mains, though the response of the spring if this were a mine related impact would be a reduction in flow rather than an increase. Montgomery (1991) attributed this flow rise to a release of collected water in the abandoned Trail Canyon Mine. This is highly unlikely as both the Trail Canyon and Bear Canyon Mines are above the regional water table, as discussed in Section 2.4.1. Additionally, a sustained discharge of 230 gallons per minute for 90 days would result in a cumulative flow volume of approximately 30 million gallons (92 ac-ft) of water. This would require a significant storage volume; assuming that four entries each 12 feet wide and 8 feet high were filled with water, they would need to be 2 miles long to be able to store the required volume of water to sustain this flow during a low flow period of the year. Prior to the increased flow at Birch Spring, the pillars were pulled in the Trail Canyon Mine. The subsidence of the mine significantly reduced the open area within the mine where water could collect. Portals on the down-dip side of the mine have been visually monitored on a regular basis since reclamation. No seepage has been observed at these portals, suggesting that the mine was dry before, during, and after the increased flow at Birch Springs (Co-Op Mining Company, 1992a). Given the contention that the area is extensively faulted and the faults and fractures are interconnected, the possibility of storing this volume of water as a perched water table above a large extent of the mine, without discharge occurring in other locations, is very unlikely.

TABLE 2-7
Summary of Birch Spring Analytical Results

Parameters	April 1987	October 1989	March 1991
pH	8.0	8.33	8.05
Conductivity (umhos/cm)	748	1090	812
TDS (mg/l)	412	810	484
TSS (mg/l)	2	56	1
Bicarbonate (mg/l)	392	367.17	376
Chloride (mg/l)	7	12.65	8.17
Sulfate (mg/l)	102	298.34	129
Calcium (mg/l)	87	128.01	101
Magnesium (mg/l)	48	71.82	42.5
Potassium (mg/l)	2	5.56	2.09
Sodium (mg/l)	7	10.80	6.1
Iron (mg/l)	<0.05	0.21	0.10
Manganese (mg/l)	<0.02	0.02	<0.02

An alternative source of the surge in flow could be the opening or connection of saturated fractures which previously did not convey water to Birch Spring. These fractures could have contained a significant volume of water which had built up over a long period of time. As these fractures drained, the flow contributed to the Birch Spring was sufficient to raise the water level in the fractures to a level which previously had not conveyed water. This would result in a flush of sediment and dissolved constituents, as reported by North Emery Water User Association, which had accumulated over time. Once the excess water in the fractures had drained the flow in the spring and the water quality returned to normal levels.

Because the period of record for Birch Spring is limited, and the published stream flow data for Huntington Creek do not include the period of record for Birch Spring, a comparison to stream flow prior to 1990 cannot be made.

The flows from Birch Spring show some seasonal fluctuation; however, three years of data do not provide sufficient information to identify the general flow characteristics. The available data (Appendix E) indicate that flow from the spring gradually diminished in 1990, an occurrence that was noted by the North Emery Water Users Association (verbal communication, 1991). Flow during 1991 was stable, with only slight fluctuations.

The declining flow at Birch Spring is considered a result of below-normal precipitation in the region over the past four to six years. Big Bear and Little Bear Springs also exhibited similar flow reductions. Here again, as proposed for Big Bear Spring, when recharge to the groundwater system is reduced below the amount required to replace the storage volume depleted by base flow discharge over the previous year, the discharge from the system at the various discharge locations is adjusted to balance the change in storage of the system.

2.8 Water Rights Search

To assist in understanding the potential impacts of the mining operations on the surrounding water resources, a search of the Utah State Water Rights records was conducted.

The computer records were scanned for all water rights, surface and groundwater, which exist in the area of Sections 10 through 15 and 22 through 27 of Township 16 South, Range 7 East. The search included an area between one half and one mile beyond the permit boundary. The water rights which were identified are located on Figure 2-3 and presented in Appendix C.

There are three surface water rights within the permit and proposed expansion areas (Figure 2-3). No springs with water rights were identified above the coal seams within the permit or proposed expansion areas. In the adjacent area, 30 surface water rights and 29 groundwater rights were identified. Fifteen of the groundwater rights were associated with flows from Big Bear and Birch Springs. The remaining rights were associated with the mines or with small stockwatering springs north of the permit area.

3.0 MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING

3.1 Well Drilling

For the purpose of collecting stratigraphic and hydrologic data for this study, three holes were drilled from the mine floor (the base of the Blind Canyon coal seam) to the Mancos Shale (Figure 3-1). A Diamec model 251 hydraulic drilling rig was used by Co-Op personnel to drill the holes, and EarthFax Engineering geologists performed lithologic logging and aquifer testing within the Star Point Sandstone. The holes were later completed as monitoring wells, to allow groundwater quality in the uppermost aquifer below the mine to be characterized. Stratigraphic logs and completion diagrams are contained in Appendix G.

The original drilling program specified the use of AW-size drilling rod and core barrels to produce a 1.89-inch diameter pilot hole, which would be enlarged by reaming to a diameter of 3 inches prior to aquifer testing. Difficulties in reaming the pilot hole required that larger BW-size equipment be used to produce a 2.36-inch diameter hole. No fluid additives or lost circulation material was used during drilling; only clear water was used as drilling fluid.

The holes were drilled and the aquifers were tested incrementally; i.e., as each aquifer was penetrated, drilling would cease, the aquifer would be isolated, and aquifer testing would be conducted. Because underlying impermeable shale was used as a seal at the bottom of the aquifer to be tested, a single packer was placed at the top of the subject aquifer. Aquifer testing procedures are discussed in Section 4.0.

<u>3.1.1 Drill Hole DH-1A</u>. To obtain detailed stratigraphic information, drill hole DH-1 was continuously cored with AW rod from the mine floor to a depth of 195 feet. Due to drill-stem instability during attempted reaming of the AW hole to a diameter of 3 inches, DH-1 was abandoned and a second hole (DH-1A) was offset approximately 20 feet to the east. DH-1A was drilled with BW rod to 195 feet (through the interval for which core had already been obtained from DH-1), and then cored continuously from 195 to 535 feet (total depth).

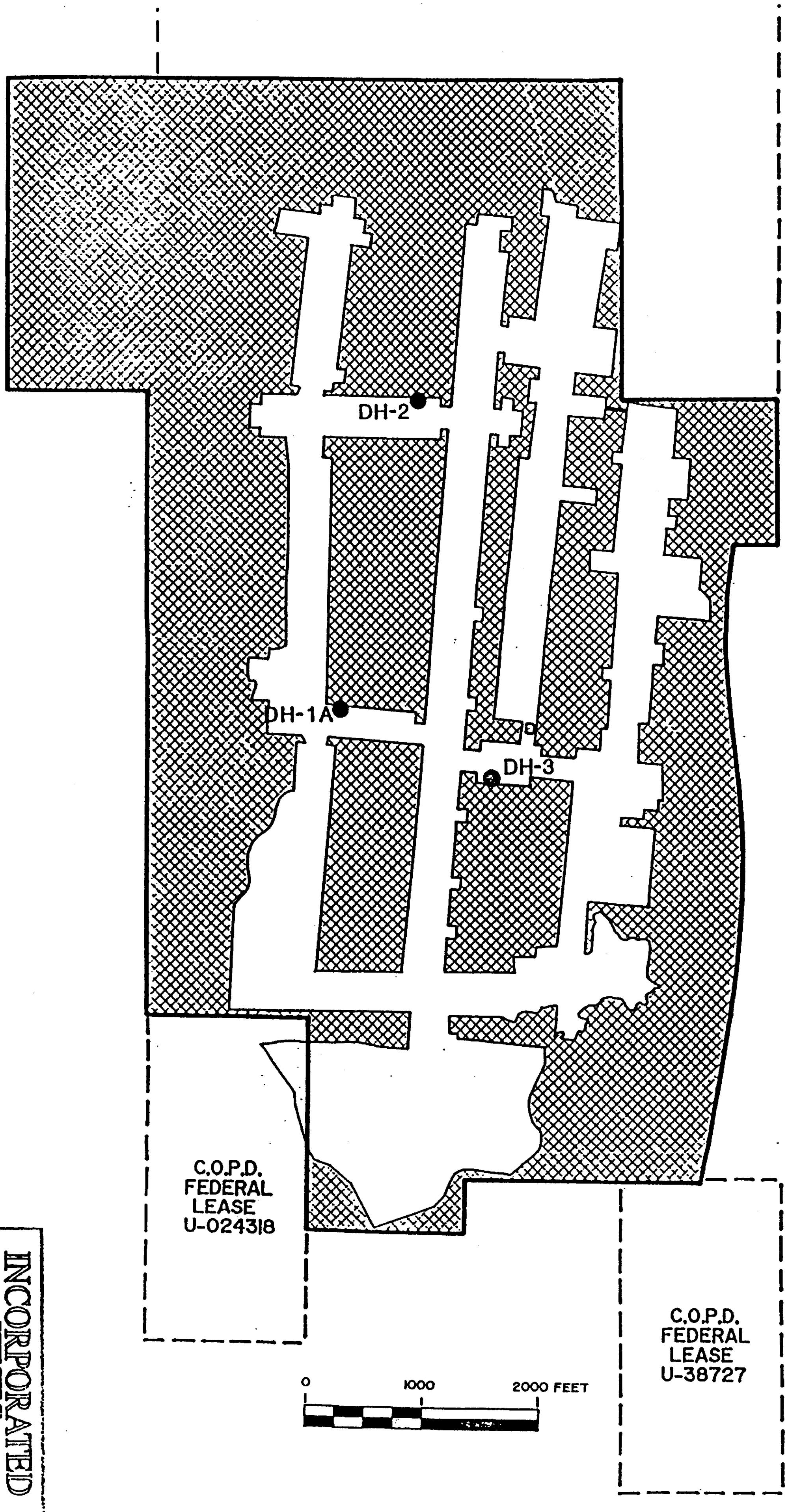

FIGURE 3-1. In-Mine Monitoring Well Locations

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As core was retrieved from the borehole, it was cleaned, described, allowed to dry, and boxed. The core boxes were permanently labeled as to the hole and depth interval from which the samples were obtained. All core samples are in the possession of Co-Op Mining Company.

3.1.2 Drill Holes DH-2 and DH-3. Drill holes DH-2 and DH-3 (Figure 3-1) were cored selectively, across intervals within which stratigraphic contacts were expected (based on the stratigraphy observed in the continuous core from DH-1 and DH-1A). Table 3-1 is a summary of intervals cored in each of the drill holes. Lithologies of drilled intervals between core runs in DH-2 and DH-3 (Appendix G) were inferred from the color of drill cuttings. Because the bit used in drilling these intervals produces a fine rock powder, no grains or lithic fragments are contained in the drilling fluid returns. DH-2 was drilled to 530 feet, and DH-3 was drilled to 545 feet below the mine floor.

3.2 Well Completion and Development

To plug the lower portion of the drill hole and isolate the Spring Canyon aquifer for well completion, DH-1A was filled with cement from a total depth of 535 feet to 171 feet below the mine floor. Due to binding of the tremie line during cement emplacement in DH-1A, gravity-emplaced granular bentonite was used to plug the lower portions of DH-2 (from 530 to 190 feet) and DH-3 (from 545 to 189 feet).

Each well was completed with 20 feet of 1.5-inch diameter, flush-threaded Schedule 40 PVC 10-slot screen set near the base of the Spring Canyon Tongue. Blank casing of the same specification was used to complete the wells to the mine floor. A 20-40 mesh silica sand filter pack was emplaced in the annular space from the bottom of the screen to the top of the Spring Canyon Tongue, and granular bentonite was placed on top of the filter-pack to prevent infiltration of cement. The upper 50 feet of annular space was filled with neat cement. A 10-inch diameter cast-iron watertight manhole was cemented flush with the mine floor at each well. To further protect the monitoring wells, wooden barricades were installed

TABLE 3-1

Summary of Cored Intervals

Drill hole I.D.	Cored Interval (depth in feet below mine floor)	Stratigraphic Targets
DH-1	0 - 195′	Continuous core.
DH-1A	195 - 535′	Continuous core.
DH-2	95 - 106′	Blackhawk/Spring Canyon contact.
	190 - 245′	Spring Canyon/Mancos No. 1/Storrs contacts.
	335 - 430′	Storrs/Mancos No. 2/Panther contacts.
	500 - 530′	Panther/Mancos Shale contact.
DH-3	82 - 98′	Blackhawk/Spring Canyon contact.
	175 - 440′	Spring Canyon/Mancos No. 1/Storrs/ Mancos No. 2 /Panther contacts.
	500 - 545′	Panther/Mancos Shale contact.

across the mine openings on either side of each well. Well completion diagrams are contained in Appendix G.

The completed wells were developed with a 1-inch diameter stainless steel bailer attached to stainless steel cable. The bailer was used to surge and bail the well until the water was visibly clean.

3.3 Groundwater Sampling

3.3.1 Monitoring Wells. One-inch diameter bladder pumps were installed in each of the three monitoring wells. The pumps can be driven with nitrogen or other non-flammable compressed gas, and are intrinsically safe for mine use. The sample lines, drive lines and the bladder are constructed of Teflon, and the pump body is stainless steel. The dedicated pumps are designed to be left in-place throughout the life of the wells, thus, the need for decontamination and storage of purging and sampling equipment between sampling rounds is eliminated.

To ensure the collection of samples representative of formation water, each well was purged of three casing volumes prior to sampling. Samples were collected in laboratory-supplied containers, and were stored in insulated ice chests at 4° C until delivery to the analytical laboratory. Laboratory analytical results for samples collected during the May 1992 sampling round are presented in Appendix H.

3.3.2 Additional Sampling Points. Groundwater-quality samples are routinely collected by Co-Op mining personnel from the North Mains section of the mine (SBC-9 and SBC-10), Bear Creek (BC-1 and BC-2), and springs associated with faults and joints in the Panther Tongue of the Star Point Sandstone (SBC-4, SBC-5, BP-1, TS-1, and CS-1). Sampling locations are depicted on Plate 2.

3.4 Radioisotope Dating

Groundwater samples were collected from SBC-4 (Big Bear Spring), SBC-5 (Birch Spring), SBC-9 (North Mains), and SBC-10 (Mine Floor water) in April, 1992, and submitted for tritium analyses to the Rosenstiel School of Marine and Atmospheric Science Tritium Laboratory in Miami, Florida.

The results of the tritium analyses are presented in Table 3-2. Tritium concentrations (expressed as tritium units, TU) for Birch Spring (1.12 TU), North Mains (0.90 TU), and the floor water (1.73 TU) are within the same order of magnitude, whereas the concentration for Big Bear Spring (17.4 TU) is an order of magnitude greater.

According to Thiros and Cordy (1991), prior to above-ground nuclear weapons tests conducted from 1953 to 1969, the natural tritium concentration in precipitation was 8.7 TU. Assuming a half-life of 12.26 years, tritium levels in groundwater stored since 1952 would now be 0.95 TU, thus, water collected from SBC-9 (North Mains) sample is likely 100% pre-bomb groundwater (water stored since before 1953). Waters from SBC-5 (Birch Spring) and SBC-10 (floor water) are probably mixtures rich in stored pre-bomb groundwater, with a slight amount of post-bomb water.

There are three possible explanations for the relatively high concentration of tritium in the SBC-4 (Big Bear Springs) water: 1) The groundwater could be freshly recharged; current tritium concentrations in freshly fallen rain water in Utah range between 10 and 20 TU (Thiros, verbal communication, 1992); 2) it could be stored post-bomb water which originally had a very high concentration of tritium which has since decayed; or 3) water from Big Bear Springs could be a mixture of pre-bomb and post-bomb waters.

Because tritium concentrations in rainwater were greater than 1000 TU during periods of active above-ground weapons testing (Fritz and Fontes, 1980), the age of water from Big

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TABLE 3-2

Tritium Analytical Results

Sampling Point I.D.	Location	Tritium Concentration
SBC-4	Big Bear Spring	17.2 TU
SBC-5	Birch Spring	1.12 TU
SBC-9	North Mains	0.90 TU
SBC-10	Floor Water	1.46 TU

Bear Spring cannot be determined. Regardless of the source(s) of recharge to Big Bear Spring, the concentrations of tritium in the remaining groundwater samples (SBC-5, SBC-9, and SBC-10) suggest that Birch Spring water and the mine inflow are of similar age (pre-1953), and are not significantly recharged by modern precipitation.

4.0 AQUIFER TESTING

4.1 General

To estimate the hydraulic conductivities of the aquifers within the Star Point Sandstone, slug injection and withdrawal tests were conducted in each of the three borings. To ensure that test results were representative of the individual aquifers, testing was done incrementally; as each aquifer was penetrated, an inflatable packer was used to isolate the subject aquifer from over- and underlying formations.

A slug test consists of rapidly changing the water level in a well or borehole by means of the injection or withdrawal of a body of known volume (a "slug") into or from the water column. When the slug is rapidly lowered into the water column, the water level rises abruptly. Rapid withdrawal of the slug after the water level has fully recovered causes the water level to drop abruptly. The rate of water level recovery to static conditions is monitored through time.

The slug used in this investigation consisted of a five-foot length of 0.5-inch diameter 316-stainless steel rod attached to 0.05-inch diameter stainless steel cable. The five-foot long slug has a displacement of 11.78 cubic inches, which is equivalent to a displacement of 3.20 feet in the 0.625-inch inside diameter of the drill rod.

Although it is recognized that the radius of influence for slug tests is smaller than for the more conventional long-term pumping tests, slug tests are considered to provide adequate information about hydraulic conditions in areas where studies are not aimed at designing an exploitation program of the aquifer (Freeze and Cherry, 1979). Both the slug injection and slug withdrawal tests produce similar results if performed under similar field conditions, and if a sufficient length of time is allowed to achieve maximum recovery of the water level.

4.2 Field Procedures

4.2.1 Water-Level and Total Depth Measurements. The static water level was measured with a pressure transducer in each subject aquifer prior to slug testing. The packer and transducer were placed at a known depth in the drill hole, and the water column height measured by the transducer was added to this known depth to approximate the water level. Total depth was determined by tallying the five-foot lengths of drill pipe as they were removed from the hole after a completed drilling or coring run.

Static water level and total depth measurements in the completed monitoring wells were made with an electric water-level indicator. Each of the measurements were made relative to the top of the protective surface casing. These values were used to determine the saturated thickness of the zone to be tested.

4.2.2 Open-Hole Slug Tests. During open-hole testing, an Instrumentation Northwest pressure transducer with an operating range of 0 to 50 pounds per square inch (up to 115.5 feet of water) was attached to the packer. Data derived from the transducer were recorded by a model 21X Micrologger manufactured by Campbell Scientific. The micrologger was programmed to record water-level changes to within 0.001 foot at either one-half second or one second intervals, depending on the response of the aquifer.

During the drilling program the bore hole was advanced through an aquifer into a confining unit. The top of the aquifer was then sealed off and isolated from overlying aquifers with a 2-inch diameter pneumatic packer (Aardvark model 12). The transducer was connected to the packer, and measured the height of the water column inside the drill stem. After pre-test measurements the slug was introduced through the drill stem and the test was recorded by the micrologger.

As data were collected, water-levels displayed by the micrologger were examined to monitor trends and the progress of the test. The accuracy and completeness of data were thereby reviewed before each test was terminated. Each test was allowed to proceed until the water-level recovered at least 95% of the height displaced by slug injection. All data were stored in the final memory of the micrologger and transferred to a data-storage module in the field. Data from the storage module were transferred to diskette storage in the office.

Following completion of the slug injection test and stabilization of the water-level, a slug withdrawal test was performed. Hence, a minimum of two tests were conducted in each well. When recovery was rapid, additional slug tests were performed. All data thus collected are on file with EarthFax Engineering.

4.2.3 Slug Tests in Completed Wells. Because the larger diameter of the well casing (1.5-inch) would permit a less restricted and more representative test (e.g., more smooth introduction and withdrawal of the slug, less turbulence within the water column) than that possible through the drill stem (0.625-inch) and packer, slug tests of the Spring Canyon Tongue aquifer were repeated after completion and development of DH-1A, DH-2, and DH-3 as monitoring wells. The hydraulic characteristics of the Spring Canyon Tongue aquifer listed on Table 4-1 and contained in Appendix F are those obtained from tests conducted in the completed wells.

A pressure transducer with a maximum operating pressure of 10 pounds per square inch (23.1 feet of water) was used to measure water levels during the slug tests in the completed and developed wells. After pre-test measurements and programming of the micrologger, the pressure transducer was lowered into the water to a depth that was below the lowest point to which the slug would be lowered, but within the depth range of the transducer. The slug was then rapidly lowered into the water column in the monitoring well, and data were recorded as in the open-hole tests.

TABLE 4-1

Hydraulic Conductivity and Transmissivity Values

Well Identification and Test Number	Aquifer Saturated Thickness (ft)	Hydraulic Conductivity (ft/day)	Transmissivity (ft^2/day)	Average Linear Velocity (ft/day)
DH-1A SPRING	88.0	0.146	12.848	0.0443
DH-1A STORRS	97.0	0.031	3.007	0.0155
DH-1A PANTHER	70.0	0.732	51.24	0.1911
DH-2 SPRING	103.0	0.012	1.236	0.0036
DH-2 STORRS	106.0	78.422[a]	8,313[a]	39.21[a]
DH-2 PANTHER	88.0	0.025	2.200	0.0065
DH-3 SPRING	65.0	0.058	3.770	0.0176
DH-3 STORRS	87.0	0.008	0.070	0.0040
DH-3 PANTHER	72.0	0.096	6.912	0.0251

[a] Anomalous value (see Section 4.4)

4.3 Interpretation Procedures

Data recorded on the data-storage module in the field were transferred to diskette by means of either a model PC201 tape and serial I/O card and associated software or a PC208 software package and serial cable with adapter, both developed by Campbell Scientific. These data sets are stored as comma-delineated ASCII data files. The contents of each data file were subsequently transferred to an analytical program (AQTESOLV™), which allows rapid, graphical representation and log-linear regression analysis of test data.

Recently published microcomputer software AQTESOLV™ (Duffield and Rumbaugh, 1989) was used to evaluate the slug test data. The method of Bouwer and Rice (1976), which determines hydraulic conductivity for wells penetrating unconfined aquifers, is available in the AQTESOLV™ software for the evaluation of slug test data, and was used to estimate the hydraulic conductivities of aquifers tested for this study.

Values of time and actual water-level displacement due to injection or withdrawal of the slug are displayed on a semi-logarithmic plot (i.e., water-level displacement is represented on a logarithmic y-axis and time is represented on a normal arithmetic x-axis). The hydraulic conductivity is estimated from the equation:

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \frac{1}{t} \ln \frac{y_o}{y_t} \qquad (4\text{-}1)$$

where:

y_o	=	initial drawdown or residual drawdown in well due to instantaneous removal or injection of the slug from the well (ft)
y_t	=	drawdown in well at time t (ft)
L	=	length of well screen (ft)
r_c	=	radius of well casing (ft)
R_e	=	equivalent radius over which head loss occurs (ft)
r_w	=	radius of well, including gravel pack (ft)
H	=	static height of water in well (ft)

t = time (min)

and

$$\ln (R_e/r_w) = \left(\frac{1.1}{\ln (H/r_w)} + \frac{C}{L/r_w}\right)^{-1} \tag{4-2}$$

where:

C = dimensionless parameter which is a function of L/r_w (see Equation 4-1);

and other parameters are previously defined.

According to Bouwer and Rice (1976), Equation (4-1) allows the hydraulic conductivity to be calculated from the water-level change in the well. Because the hydraulic conductivity, casing radius, well radius, the radius over which head loss occurs, and the screen length are constants, $(1/t) \ln y_o/y_t$ must also be a constant. Thus, the time-drawdown data should approximate a straight line if plotted in terms of $\ln y_o$ versus t. The quantity $(1/t) \ln y_o/y_t$ in Equation (4-1) is obtained from the first straight-line segment drawn through the field data.

The AQTESOLV™ software program prompts the user to supply values of well casing radius, drill hole radius, aquifer saturated thickness, well screen length, and static height of water in the well. Time and water-level data are read into the software program in the form of ASCII data files, which are down-loaded from the field data-logger.

Once the field data and constants are entered, the AQTESOLV™ software generates semi-log plots of the data and automatically fits a straight line to the data according to user-defined weighting. If the entire range of field data do not approximate a straight line, only those early data which form a valid straight-line segment are weighted by the user such that the software package produces the desired straight line approximation through the valid part of the data set.

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The straight-line fit produced by AQTESOLV™ automatically determines the value of y_o (y-intercept) and an arbitrary value of y_t at time t to solve Equation (4-1). Based on user-defined values of screen length and drill hole radius, the software determines the value of C to evaluate R_e in Equation (4-2).

The software generates the straight line approximation by means of a nonlinear weighted least-squares parameter estimation technique, i.e., the Gauss-Newton linearization method (Duffield and Rumbaugh, 1989). The estimation technique minimizes the difference between observed and estimated values through iterative solution of the system of linearized equations until convergence is achieved. To ensure the fit of the straight line, the software prints out the values of actual water levels, calculated water levels, and residual values (the difference between the actual and calculated water levels) derived by the parameter estimation technique. Additionally, the statistical values of mean, standard deviation, and variance also are provided for the weighted residuals. These statistics indicate the goodness-of-fit of the straight line generated through the weighted slug test data by the estimation technique. Table 4-2 is a summary of the information collected in the field and subsequently used in the slug test analyses.

4.4 Aquifer Test Data and Results

Slug test plots for the wells tested are presented in Appendix F. Included with the time-drawdown plots are printouts of well constants and field data used to estimate values of hydraulic conductivity. Also listed in Appendix F are values of actual water levels, calculated water levels, and residual values (the difference between the actual and calculated water levels) derived by the parameter estimation technique. Statistical values of mean, standard deviation, and variance also are provided for the weighted residuals. Table 4-1 is a summary of aquifer saturated thickness, hydraulic conductivity, transmissivity, and average linear velocity values calculated for each well.

TABLE 4-2

Slug Test Input Data

Well Identification And Test Number	Static Water Level (ft btc*)	Diameter Of Casing (in)	Radius Of Borehole (in)	Screen Length (ft)	Total Depth (ft)	Aquifer Saturated Thickness (ft)
DH-1A SPRING	70.0	2.5	2.9	20.0	171.0	70.0
DH-1A STORRS	97.0	2.9	2.9	95.0	NA	97.0
DH-1A PANTHER	70.0	2.9	2.9	60.0	NA	70.0
DH-2 SPRING	160.0	2.5	2.9	20.0	190.0	160.0
DH-2 STORRS	106.0	2.9	2.9	104.0	NA	106.0
DH-2 PANTHER	190.0	2.9	2.9	86.0	NA	88.0
DH-3 SPRING	50.0	2.5	2.9	20.0	190.0	50.0
DH-3 STORRS	127.0	2.9	2.9	70.0	NA	72.0
DH-3 PANTHER	72.0	2.9	2.9	70.0	NA	72.0

* Below Top of Casing.

The hydraulic conductivity values used are taken directly from AQTESOLV™ plots, and a plot from each slug test is analyzed. Plots with convoluted or broken data lines are rejected. Plots from tests that were aborted prematurely or had other technical difficulties are also rejected. One plot was selected per formation, per hole from the remaining plots, based on goodness of fit.

According to Driscoll (1986), hydraulic conductivity indicates the quantity of water that will flow through a unit cross-sectional area of a porous media per unit time. Transmissivity is the transmission capability of an aquifer, and can be calculated by multiplying the saturated thickness of an aquifer by its hydraulic conductivity.

The horizontal rate of groundwater flow (or average linear velocity) of groundwater in each tested aquifer was calculated using a modified form of the Darcy equation (Freeze and Cherry 1979):

$$\bar{v} = (K/n)(dh/dl) \qquad (4\text{-}3)$$

where:

v	=	average linear groundwater velocity (ft/day).
K	=	hydraulic conductivity (ft/day).
n	=	porosity (fraction).
dh/dl	=	hydraulic gradient (ft/ft).

Calculation results are shown in Table 4-1. The results from all of the tests are deemed satisfactory, with the exception of tests run on the Storrs Tongue aquifer in DH-2. During analysis of test data for this aquifer and later field checks, it was discovered that the packer bladder had not seated properly during slug testing of this interval, and had allowed water to communicate around the packer. This fact explains the very large discrepancy between the values from this unit, as compared to values derived from Storrs tests in DH-1A and DH-3.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on this study the following conclusions are made:

- The groundwater system in the area of the Trail Canyon and Bear Canyon mines in mainly controlled by geologic structures (faults and fractures) and lithology.

- In the area of present development, the regional water table is located below both the Blind Canyon and Hiawatha seams in the Bear Canyon mine, as indicated by in-mine drilling and aquifer testing. The three aquifers within the Star Point Sandstone have separate, distinct static water levels, and are not fully saturated in the southern portion of the permit area.

- At the present time, there is no evidence to suggest that interception of water within the workings of the Bear Canyon mine has had an impact on water quantity or quality at Big Bear Spring or Birch Spring.

  - Tritium analyses suggest that Bear Canyon Mine water is primarily relict "pre-bomb" water, and does not recharge Big Bear Spring which is "post-bomb" (more recently recharged) water.

  - Analysis of Piper diagrams does not suggest a hydraulic relationship between Bear Canyon Mine water and the water from Birch Springs.

- Analytical results of groundwater samples collected in 1991 indicate that water intercepted by and stored in sumps within the Bear Canyon Mine is of higher quality than that discharged at Big Bear and Birch Springs.

- o Mine water discharge may increase the quantity and improve the quality of water in Bear Creek.

- o Subsidence over the southwest portion of the Bear Canyon Mine cannot impact Birch Springs; Blind Canyon truncates the coal seam before it reaches Blind Canyon Fault or the fault and fracture zone associated with Birch Springs.

- o The recent reductions in spring flows appear to be the result of significant reductions in precipitation amounts over the last five to six years.

5.2 Recommendations

The following recommendations are presented to assist in addressing some of the concerns of the water companies and the Utah Division of Oil, Gas, and Mining:

- o Co-Op Mining Company should continue to periodically monitor flows and water quality at Big Bear and Birch Springs. Regular monitoring will ensure the collection of adequate data for the evaluation of potential mining-related impacts to the springs. Each round of flow monitoring and sample collection should be performed by the same individual, to reduce the possibility of error due to technique.

  Special attention should be paid to sampling and preservation techniques. Recently obtained comparative laboratory results should be reviewed and consideration should be given to the selection of a new laboratory. Quality assurance/quality control samples should be submitted with each round of samples, to allow sampling techniques and laboratory performance to be evaluated.

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Waddell, K.M., P.K. Contratto, C.T. Sumsion, and J.R. Butler, 1981. Hydrologic Reconnaissance of the Wasatch Plateau-Book Cliffs Coal-Fields Area, Utah. U.S. Geological Survey, Water Supply Paper 2068. Washington, D.C.

TECHNICAL ANALYSIS

Tank Seam Road
Co-Op Mining Company
Bear Canyon Mine
ACT/015/025

July 20, 1994

BIOLOGICAL ANALYSIS

R645-301-321. Vegetation Information.

Plate 9-1, Vegetation Map, is included in the submittal for the proposed Tank Seam Road and Portal Pad. The new vegetation map has been updated to include the Tank Seam reference area. The existing vegetation in the area of the proposed disturbance is included on the map.

An inspection of the proposed road was made by Forest Botanist Robert Thompson on November 4, 1993, for threatened, endangered and sensitive plant species (page 9B-5). He stated that the area was clear of any species of concern.

R645-301-322. Fish and Wildlife Resource Information.

No additional fish and wildlife resource information specific to the Tank Seam road and portal pad was provided in this amendment. The resource information included in the permit is general enough to cover this area which is close to the other disturbed areas. The raptor survey included the proposed area of disturbance. The entire area is classified as critical deer and elk winter range.

A letter dated December 23, 1992 from DWR (page 10D-18) recommended the current proposed road route over other alternative routes because of less impact. The letter states that the known golden eagles nest within one-half mile of the road are not located in direct line of site. However, the lower cliff areas are potential Townsend Big-eared bat habitat. A survey of the area for this species must be complete prior to construction of the road and pad as required by R645-301-322.100.

R645-301-410. Land Use.

No amendment to the plan has been made for this section. The stated premining land use for the area is wildlife and grazing. R645-301-411.110 requires the amendment to state the current land use for the area which in this case would be only wildlife. Due to the steepness of the site, livestock grazing would be prohibitive.

The current productivity of the area to be disturbed has not been described as required by R645-301-411.100. The Division will accept a letter from the SCS which states the estimated current and potential productivity of the reference area to fulfill this requirement.

EXHIBIT B

Stipulations

6. The Operator must expose bedrock when needed to ensure that the slope is stepped.

7. The Operator must test fill material prior to placement.

8. The Operator must submit detailed slope profiles and stability analysis for each fill-slope.

BASELINE DATA

R645-301-729. Cumulative Hydrologic Impact Assessment

Revised Hydrologic Evaluation of the Bear Canyon Mine

In the review of additional information to put together the 'Revised Hydrologic Evaluation of the Bear Canyon Mine' the following items were considered: 1) the updated PHC (Probable Hydrologic Consequences) data submitted by Co-Op Mining Company, and 2) the September 9, 1993 informal hearing transcripts.

Ground Water

Within the vicinity of the Bear Canyon Mine, two major springs have been identified: Big Bear Springs and Birch Springs. Big Bear Springs (maintained by the Castle Valley Special Services District) discharges from three prominent joints. Birch Springs (maintained by the North Emery Water Users) discharges from the normal fault which has approximately 20 feet of vertical displacement. Both springs discharge from the lowest sandstone unit of the Star Point Sandstone (Panther Tongue), where the Mancos Shale acts as a barrier to the downward movement of groundwater. As a result of the Order issued by the Division of Oil, Gas and Mining, Co-Op Mining Company initiated a drilling program to better define the ground water flow path associated with the Blackhawk-Starpoint aquifer in the area of the mine.

Although a regional aquifer (termed the Star Point - Blackhawk Aquifer by Danielson, et al., 1981) has been designated for the area, in-mine drilling and aquifer testing conducted for this study area indicate that three aquifers within the Star- Point Sandstone have individual static water levels. Further, in the southernmost hole (DH-3) shown on Plate 2, PAP, none of the three aquifers are fully saturated. This fact indicates that each of the units have a separate and distinct water levels. The springs issue from the bottom of the Panther Tongue (417 - 433 feet below the Blackhawk formation contact with the Star Point Sandstone), therefore, Birch Springs and Big Bear Springs are hydrologically isolated from the impacts of mining in the Blackhawk Formation by the presence of two Mancos Tongues in the Star Point Sandstone.

Areas of encountered groundwater within the mine are fractures which drain over a period of several months as the mine advances northward. This indicates a high degree of hydraulic interconnection through fractures in the portion of the Blackhawk Formation which overlies the mine. Inflows in the north end of the North Main and Second East entries are through roof bolt holes and hairline fractures which are presumed to drain overlying perched aquifers in the Blackhawk Formation. The current rate of discharge from the mine is approximately 300 GPM.

Big Bear Springs and Birch Springs in the vicinity of the Bear Canyon Mine issue from joints at the contact between the Panther Tongue and the Mancos Shale. The majority of water inflows in the mine are through bolt holes and fractures draining perched aquifers in the Blackhawk and an indeterminate amount of interception of water from the floor in the area of the Second East entries. The review of water source information, the graphical tracking of precipitation versus flow, the testing of the spring water and mine water quality for tritium dating, analysis of water quality chemical data using Stiff and Piper diagrams, and the known presence of three separate piezometric surfaces based on drilling in the Spring Canyon, Storrs, and Panther Tongues of the Star Point Sandstone leads to a conclusion of no significant material damage to the Hydrologic Balance outside the permit area.

Future Mining in the Tank Seam above the Bear Canyon Seam

The Co-Op Mining Company has drilled 8 exploratory drill holes into the Tank Seam (page 2-13, Appendix 7 - J, PAP). All were dry except one which flows at .5 GPM (drilled up from the mine workings in the Blind Canyon Seam). The inflows into the Tank Seam are expected to be much less than those encountered in the Blind Canyon Seam. Stratigraphically, the Tank Seam is 250 feet above the Blind Canyon Seam and therefore, would tend to be drier and not expected to have the ground water inflows found in lower coal seams (i.e., the Blind Canyon and the Hiawatha Seams). There has been no continuous water quality problems associated with mine water discharge at the Bear Canyon Mine and therefore it is not expected to change in the future, although it will be closely watched for any long term trends.

Surface Water

The Permittee has submitted information in their PHC which documents the quality and quantity of surface water routinely collected in the permit and adjacent areas from stations located on Bear Creek and Trail Creek. Analytical data from these sources are summarized in Chapter 7 of the PAP and the Annual reports. Locations of these monitoring points are presented on Plate 7-4 of the PAP. The following potential impacts are discussed in the PHC on pages 3-10 thru 4-3:

- Contamination from acid- or toxic-forming materials;
- Increased sediment yield from disturbed areas;
- Flooding or stream flow alteration;
- Impacts to the chemical quality of surface water; and
- Impacts to surface water quantity.

The Permittee has provided a summary of the potential impacts based on the Potential Magnitude of Impact and the Probability of Occurrence. The two potential impacts to surface water quality with moderate or high probability of occurrence are in order, road salting and mine discharge. Both potential impacts are being monitored, by monitoring treatments in place (i.e. sediment ponds). Any mitigation of road salting within the permit area will be based on UPDES permit requirements. The monitoring of discharge and underground occurrence are in place to determine if mitigation measures are needed.

The Permittee has provided an adequate erosion and sediment control plan for reclamation of the Tank Seam and therefore a Cumulative Hydrologic Impact Assessment can be completed.

Finding

The Permittee has met the requirements of the rules regarding the collection of Baseline ground and surface water data. The Permittee has also provided an accurate assessment of the potential impacts from mining the Tank Seam. The Permittee has met the requirements of the rules regarding erosion and sediment control for reclamation.

EROSION AND SEDIMENT CONTROL

R645-301-741 thru
742.126 and 742.240 **Sediment Control Measures**

Operation Plan

The Permittee is proposing to build a road and pad area isolated from the normal sediment control facilities at the main facilities area in steep canyon which is considered a space limited environment. Therefore, the Operator has decided to treat all disturbed areas using alternative sediment control (i.e., silt fence and erosion control matting). The Permittee meets the regulatory requirements of R645-301-741 through 742.126 and 742.240. The construction procedures for installation of sediment controls are described on pages 3H-

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Attorneys for Respondent
Co-op Mining Company

FILED
SEP 1 2 1994
SECRETARY, BOARD OF
OIL, GAS & MINING

BEFORE THE BOARD OF OIL, GAS AND MINING
DEPARTMENT OF NATURAL RESOURCES, STATE OF UTAH

IN THE MATTER OF THE REQUEST FOR AGENCY ACTION BY PETITIONERS NORTH EMERY WATER USERS ASSOCIATION, HUNTINGTON-CLEVELAND IRRIGATION COMPANY, and CASTLE VALLEY SPECIAL SERVICES DISTRICT	DESIGNATION OF EXHIBITS Docket No. 94-027 Cause No. ACT/015/025-93B

Pursuant to R641-105-500, Permittee/Respondent C.W. Mining Company d/b/a Co-op Mining Company (Co-op) hereby designates as Exhibits filed with the secretary of the Board the following documents:

1. All documents previously filed by Co-op with the Division in this matter.
2. Co-op's Permit, with all revisions, amendments and supplements thereto.
3. All previous Orders and Decisions of the Board and Division addressing the hydrology or geology of the Trail Canyon, Bear Canyon and surrounding areas.

DATED this 9 day of September, 1994.

Mark Hansen
~~Attorney for Plaintiff~~

CERTIFICATE OF SERVICE

I hereby certify that I have this day served the foregoing instrument upon all parties of record in this proceeding by mailing a copy thereof, properly addressed, with postage prepaid, to:

David B. Hartvigsen
NIELSEN & SENIOR
1100 Eagle Gate Tower
60 East South Temple
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Attorneys for
North Emery Water Users' Association and
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Jeffrey W. Appel
Michele Mattsson
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9 Exchange Place, Suite 1100
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Attorneys for
Castle Valley Special Service District

Dated at Salt Lake City, Utah this 9 day of September, 1994.

Mark Hansen

2005p.002

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Attorneys for Respondent Co-op Mining Company

FILED
OCT 20 1994
SECRETARY, BOARD OF OIL, GAS & MINING

BEFORE THE BOARD OF OIL, GAS AND MINING
DEPARTMENT OF NATURAL RESOURCES, STATE OF UTAH

IN THE MATTER OF THE REQUEST FOR AGENCY ACTION BY PETITIONERS NORTH EMERY WATER USERS ASSOCIATION, HUNTINGTON-CLEVELAND IRRIGATION COMPANY, and CASTLE VALLEY SPECIAL SERVICES DISTRICT	FINAL EXHIBIT LIST Docket No. 94-027 Cause No. ACT/015/025-93B

C.W. Mining Company d/b/a Co-op Mining Company (Co-op) submits the following exhibits pursuant to R641-105-500 and -600. All exhibits were identified in Co-op's September 9, 1994 Designation of Exhibits.

EX.#	DESCRIPTION
A	07/21/95 "Significant Permit Revision Approval" (DOGM)
B	07/20/95 "Technical Analysis" -- pages 1, 21,22,23 (DOGM)
C	04/30/93 "Probable Hydrologic Consequences of Mining At Bear Canyon Mine, Emery County, Utah" (Earthfax Engineering, Inc.)
D	04/26/93 "Revised Hydrogeologic Evaluation of the Bear Canyon Mine Permit And Proposed Expansion Areas" (Earthfax Engineering, Inc.)

DATED this 20 day of October, 1994.

Mark Hansen
Attorney for Respondent

CERTIFICATE OF SERVICE

I hereby certify that I have this day served the foregoing document upon all parties of record in this proceeding by mailing a copy thereof, properly addressed, with postage prepaid, to:

David B. Hartvigsen
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Jeffrey W. Appel
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Attorneys for
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Dated at Salt Lake City, Utah this 20 day of October, 1994.

Mark Hansen

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FILED

OCT 1 1 1994

SECRETARY, BOARD OF
OIL, GAS & MINING

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Special Service District

BEFORE THE BOARD OF OIL, GAS, AND MINING

DEPARTMENT OF NATURAL RESOURCES, STATE OF UTAH

IN THE MATTER OF THE REQUEST FOR AGENCY ACTION BY PETITIONERS NORTH EMERY WATER USERS ASSOCIATION, HUNTINGTON-CLEVELAND IRRIGATION COMPANY, AND CASTLE VALLEY SPECIAL SERVICES DISTRICT	)))))))	**EXHIBIT LIST** DOCKET NO. 94-027 CAUSE NO. ACT/015/025

Protestants/Appellants, North Emery Water Users Association and Castle Valley Special Services District respectfully submits an original and twelve copies of the following exhibits pursuant to R641-105-500 and R64-105-600.,

1. USGS Map of Area.
2. Permit for Birch Spring from BLM.
3. Photograph of Spring Development, Birch Spring.

4. Photograph of Spring Development, Birch Spring.

5. Cost of Spring Development, Birch Spring.

6. Geologic Map.

7. Rock Formation Chart.

8. Generalized Geologic Diagram.

9. Geologic Section.

10. Photograph and Charts of Impact of Mining on Water.

11. Cross-Section Charts on Mine Dewatering (color).

12. Generalized Geologic Diagram.

13. Photograph Mine Seepage.

14. Photograph, Close up, Mine Seepage.

15. Comparative Flow Graph 1980-1994.

16. Comparative Flow Graph 1989-1994.

17. Public Law 720(c)(2).

DATED this 11th day of October, 1994.

NIELSEN & SENIOR, P.C.

David B. Hartvigsen
Attorneys for Protestants

CERTIFICATE OF MAILING

I hereby certify that a true and correct copy of the foregoing **EXHIBIT LIST** was mailed, to the addresses listed below by depositing the same in the United States mail, postage pre-paid, on this 11th day of October, 1994:

Wendell Owen
Co-op Mining Company
P.O. Box 1245
Huntington, Utah 84528

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341 South Main, Suite 406
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FILED
OCT 21 1994
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BEFORE THE BOARD OF OIL, GAS, AND MINING

DEPARTMENT OF NATURAL RESOURCES, STATE OF UTAH

IN THE MATTER OF THE REQUEST FOR AGENCY ACTION BY PETITIONERS NORTH EMERY WATER USERS ASSOCIATION, HUNTINGTON-CLEVELAND IRRIGATION COMPANY, AND CASTLE VALLEY SPECIAL SERVICES DISTRICT	)))))))	**SUPPLEMENTAL EXHIBIT LIST** DOCKET NO. 94-027 CAUSE NO. ACT/015/025-93B

Protestants/Appellants, North Emery Water Users Association and Castle Valley Special Services District respectfully submit an original and eighteen copies of the following exhibit pursuant to R641-105-500 and R64-105-600.,

Exhibit No. 18 Big Bear Spring Water Quality Data

DATED this 21st day of October, 1994.

NIELSEN & SENIOR, P.C.

David B. Hartvigsen
Attorneys for Protestants

CERTIFICATE OF MAILING

I hereby certify that a true and correct copy of the foregoing **SUPPLEMENTAL EXHIBIT LIST** was mailed, to the addresses listed below by depositing the same in the United States mail, postage pre-paid, on this 21st day of October, 1994:

Carl E. Kingston, Esq.
3212 South State Street
Salt Lake City, Utah 84115

CERTIFICATE OF HAND DELIVERY

I hereby certify that a true and correct copy of the foregoing **SUPPLEMENTAL EXHIBIT LIST** and a copy of Exhibit No. 18 were hand delivered to the address listed below on this 21st day of October, 1994:

F. Mark Hansen, Esq.
341 South Main, Suite 406
Salt Lake City, Utah 84111

PS>C:\FILES\NO-EMERY.EX2

FILED

OCT 2 0 1994

SECRETARY, BOARD OF
OIL, GAS & MINING

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BEFORE THE BOARD OF OIL, GAS, AND MINING

DEPARTMENT OF NATURAL RESOURCES, STATE OF UTAH

IN THE MATTER OF THE REQUEST FOR AGENCY ACTION BY PETITIONERS NORTH EMERY WATER USERS ASSOCIATION, HUNTINGTON-CLEVELAND IRRIGATION COMPANY, AND CASTLE VALLEY SPECIAL SERVICES DISTRICT	PETITIONERS RESPONSE TO CO-OP'S INTERROGATORIES TO PETITIONERS Docket No. 94-027 Cause No. ACT/015/025-93B

Petitioners respectfully respond to Co-op's Interrogatories as follows:

INTERROGATORY: Please identify each person whom you expect to call as an expert witness at the hearing in this matter, and for each such person, please state the following:

a. State the person's full name, address and telephone number.

b. State the education, training, experience, and other facts upon which you expect to rely to qualify the person as an expert witness.

c. State the subject matter on which the person is expected to testify.

d. State the substance of the facts and opinions to which the person is expected to testify.

e. Provide a summary of the grounds for each opinion.

f. Identify all documents reviewed by or prepared by the person in connection with the formulation of the person's opinions.

RESPONSE TO INTERROGATORY

a. S. Bryce Montgomery
3512 South 100 East
Bountiful, Utah 84010
(801) 295-8592

b. Bachelor of Science Geology. Graduate work in Geology and Engineering. Hydrological Engineer, Utah State Engineers office; Petroleum Geologist; Geologist and Chief Geologist, Utah Division of Water Resources. Registered Professional Geologist, State of Wyoming. Thirty-five years professional geological and hydrological experience.

c. Geology, Groundwater Hydrology, the effect of Co-op's Mining operations and mine dewatering, and proposed future mining operations and mine dewatering on Big Bear Spring and Birch Spring.

d. The substance of the facts and opinions to which Mr. Montgomery is expected to testify are that the activities of

Co-op Mining in operating its mine in Big Bear Canyon including its mine dewatering and mine water utilization causing an impact on both Big Bear Spring, which is utilized for drinking water purposes by Castle Valley Special Services District, and Birch Spring, which is utilized for drinking water purposes by North Emery Water Users Association.

This impact by Co-op has caused both decreased flows of the Springs and deterioration of water quality. These impacts are measurable from the decreased flows of both springs and are due to the hydrologic connection between the aquifer being dewatered in Co-op's mining operations and the aquifers from which Birch Spring and Big Bear Spring issue. This interconnection is due primarily to faulting. See also subpart c.

e. See Response to Subpart d. and f.

f. All hydrology documents including the PHC and CHIA on file regarding Co-op Mine at DOGM. The groundwater system and possible effects of underground coal mining in the Trail Mountain Area, Central Utah by Gregory Lines. Hydrology of Area 56, Northern Great Plains and Rocky Mountain Coal Provinces, Utah, by Gregory C. Lines. Hydrology of Alkali Creek and Castle Valley Ridge Coal Lease Tracts, Central Utah and Potential Effects of Coal Mining by R. L. Seiter and R. L. Baskin. Hydrology of the Coal Resource Areas in the Upper Drainages of Huntington and Cottonwood Creeks, Central Utah, by Danielson, ReMillard and Fuller. Hydrology of Coal Resource Areas in the Southern Wasatch Plateau, Central Utah, by Terrence Danielson and Dean Sylla. Hydrology of the Price River Basin, Utah, with Emphasis on Selected Coal-field areas by K. M. Waddell.

All of the above are U.S.G.S. publications.

Precipitation data for the immediate area of the springs obtained from SCS and spring flow data obtained from records of North Emery Water Users, Co-op Mining and Castle Valley Special Services District.

DATED this 19th day of October, 1994.

NIELSEN & SENIOR, P.C.

David B. Hartvigsen

David B. Hartvigsen
Attorneys for North Emery Water Users Association and Huntington-Cleveland Irrigation Company

STATE OF UTAH)
:ss.
COUNTY OF SALT LAKE)

On the 19 day of October, 1994, personally appeared before me David B. Hartvigsen, the signer of the within instrument, who duly acknowledged to me that he executed the same.

NOTARY PUBLIC
JANAE NOVAK
60 East So. Temple #1100
Salt Lake City, Utah 84111
My Commission Expires
January 3, 1998
STATE OF UTAH

My Commission Expires:

Janae Novak

NOTARY PUBLIC
Residing at

56

CERTIFICATE OF SERVICE

I hereby certify that on this 19 day of October, 1994, I have caused to be sent, through the United States mail, first-class, postage prepaid, a true and correct copy of the foregoing PETITIONERS RESPONSE TO CO-OP'S INTERROGATORIES TO PETITIONERS addressed as follows:

Carl E. Kingston, Esq.
3212 South State Street
Salt Lake City, UT 84115

F. Mark Hansen, Esq.
341 South Main, Suite 406
Salt Lake City, UT 84111

BEFORE THE BOARD OF OIL, GAS AND MINING

DEPARTMENT OF NATURAL RESOURCES

IN AND FOR THE STATE OF UTAH

IN THE MATTER OF T REQUEST FOR AGENCY ACTION AND 'EAL OF DIVISION DETERMIN ON TO APPROVE SIGNIFICANT REVIS TO PERMIT TO ALLOW MINING OF TA SEAM BY CO-OP MINING COMPANY BY PETITIONERS NORTH EMERY WATER USERS ASSOCIATION, HUNTINGTON-CLEVELAND IRRIGATION COMPANY, AND CASTLE VALLEY SPECIAL SERVICES DISTRICT, CARBON COUNTY, UTAH.	DOCKET NO. 94-027 CAUSE NO ACT/015/025

TUESDAY, OCTOBER 25, 1994, COMMENCING AT THE HOUR OF 9:00 A.M., A HEARING WAS HELD IN THE ABOVE MATTER BEFORE THE BOARD OF OIL, GAS, AND MINING, 355 WEST NORTH TEMPLE, 3 TRIAD CENTER, SUITE 520, SALT LAKE CITY, UTAH 84180-1203.

INTERMOUNTAIN COURT REPORTERS
5980 SOUTH 300 EAST
MURRAY, UTAH 84107
801 263-1396

FILE NO. 102594

REPORTED BY:
LINDA J. SMURTHWAITE, CSR, RPR, CM

ORIGINAL

APPEARANCES

CHAIRMAN: DAVE LAURISKI

BOARD MEMBERS:

RAYMOND MURRAY
ELISE L. ERLER
JAY CHRISTENSEN
KENT STRINGHAM
JUDY LEVER
THOMAS FADDIES

STAFF:

JAN BROWN, Secretary to the Board
JANEAN BURNS, Legal Secretary
BILL RICHARDS, Assistant Attorney General
JIM CARTER, Director, Division of Oil, Gas and Mining
JOE HELFRICH, Permit Supervisor
DARON HADDOCK, Permit Supervisor
RON DANIELS, Coordinator of Minerals Research

INDEX

SALT LAKE CITY, UTAH, OCTOBER 25, 1994, 9:00 AM

MR. LAURISKI: Good morning. We'll go on the record now. This is a matter before the Board of Oil, Gas and Mining in the matter of the request for Agency Action and Appeal of Division determination to approve significant revision to permit to allow mining of Tank Seam by Co-op Mining Company by petitioners North Emery Water Users Association, Huntington Cleveland Irrigation Company, and Castle Valley Special Services District, Carbon County, Utah.

This is Docket No. 94-027, Cause No. ACT/015/025. If counsel would enter their appearance for the record, please.

MR. SMITH: Craig Smith, appearing on behalf of petitioner, North Emery Water Users Association and Huntington Cleveland Irrigation Company.

MR. APPEL: Jeffrey Appel on behalf of Castle Valley Special Service District, petitioners.

MR. MITCHELL: Tom Mitchell on behalf of the Division of Oil, Gas and Mining, respondents.

MR. HANSEN: Mark Hansen for Co-op.

MR. KINGSTON: Carl Kingston on behalf of Co-op Mining Company.

MR. LAURISKI: Thank you. The first issue that we need to address this morning are procedural issues that familiar as we could be with what the development of a spring, at least as far as Birch Springs, entail. Take a minute and just maybe describe what work was done for the development of Birch Springs?

A. Well, we went in.

MR. HANSEN: We have given a lot of latitude and I object on foundation grounds and ask petitioners to establish some foundation so this testimony is relevant to the issue.

MR. LAURISKI: I think that's appropriate Mr. Smith.

MR. SMITH: I guess I'm confused. I've heard -- is it a foundation or relevance objection?

MR. HANSEN: At this point I'm objecting for lack of foundation. If they can't show foundation then I'll object to relevance.

MR. LAURISKI: As to the relevance.

MR. SMITH: I believe the relevance -- you know, I can speak to either one or both. Mr. Allred testified he was personally involved with the development work so he has personal knowledge of what happened there and can testify as to that. As far as the relevance, I just want to point out that the efforts that went in to develop Birch Springs as a resource for North Emery Water Users, and we believe it provides foundation for later testimony our expert will give as to water that should be intercepting what it could intercept or has intercepted in the past, and that the development work should be intercepting the water that's there.

MR. HANSEN: Well, the issue again is what effect Co-op's mining of the Tank Seam has on those springs and I object to the testimony they are proffering here on the relevance grounds.

MR. SMITH: Well, if Co-op wants to limit any of its testimony to that and not raise any issue about whether we properly developed the spring and we are capturing the water that's in the spring, we can move ahead. But I don't want to be in a position where I've bypassed some evidence and have them bring arguments that, i.e., we did not develop the spring, or the spring wasn't properly developed, and that's the reason why, when we show what flows we're getting out of the spring, they attack that evidence as saying that's not the flows from Birch Springs, you are just not capturing the flows in your system so you are not getting the entire flow.

And so I'm happy to shorten the issue. I don't want to leave myself in a position where I haven't put on the proper evidence and when it's their turn have that kind of evidence brought by them, and me not having put on the evidence about our developing the spring.

MR. LAURISKI: Why don't you continue and the Board will consider whatever weight that we can afford this exhibit. We'll reserve our decision on your objection.

MR. HANSEN: I'll ask that he lay a foundation. If he lays it, that's fine.

BY MR. SMITH:

Q. Mr. Allred, were you personally involved in the development work of Birch Springs in the 1980's?

A. Yes, I was.

Q. And did you personally go observe the work that was done?

A. Yes, I did.

Q. And did you observe --

MR. LAURISKI: Mr. Smith, could you lean forward and closer to the microphone, please. Thank you. Mr. Allred, I'm sorry.

BY MR. SMITH:

Q. And did you observe the construction work that's depicted in Exhibit 3?

A. Yes.

Q. And does Exhibit 3 accurately depict development work that was done at Birch Springs?

A. Yes, that was why we went in there. We was already getting 20 gallons a minute out of the part that has been developed. And so we went in and redeveloped the whole thing and only gained 100 some gallons a minute, but we couldn't put it right in. And when we put it in, it was 90 some gallons and that was during the same time as they were mining at Co-op mine.

Q. So after the development work was done you were able to -- how much water were you able to capture from Birch Springs?

A. They was over 200 some gallons that was captured in there, that we was capturing in there.

Q. Okay. And I'm showing you what's been marked as Exhibit 4 and ask if you can identify that?

A. Yes, that was some more from when we was starting to really dig down into Birch Springs trying to get down to the sources of the springs.

MR. LAURISKI: So this is simply additional development work in the Birch Springs area?

THE WITNESS: Yes, more of the same.

MR. LAURISKI: If you look at Exhibit 3, it's actually more to the left of it, as I look at this; is that correct?

THE WITNESS: Yes.

MR. LAURISKI: Okay.

BY MR. SMITH:

Q. And I'd like you to take a look, and have you look at Exhibit 5, and ask if you can identify Exhibit

5.

A. Yes, these are checks we wrote to Tony Sapieress for 17,360.39. $21,460.

Q. And what were those checks to pay for?

A. This was to pay for development work in Birch Springs.

Q. Okay. And on the second page can you identify the second page of Exhibit 5?

A. Yeah, this is where we went in and got the water right from the ledge itself. One and two on there.

Q. And that's what, a drawing of some development work?

A. This is a drawing of the development work that was done in there.

Q. Okay. And prior to any development at all, where did the water issue from Birch Springs, when you say the rock ledge itself?

A. Before it was coming out right along where that hydrohole is sitting on this one picture you got, this -- which one is this one?

MR. MITCHELL: Three.

THE WITNESS: This creek was running water down through it, the stream bed was running water before we went in and developed it.

MR. LAURISKI: And I may have missed this, what year was that?

THE WITNESS: This was in '83 or '84, right in there.

BY MR. SMITH:

Q. Was that the first time that Birch Springs had been developed for use by North Emery Water Users?

A. No, it was developed in '76, I think, the first time, and that's when we was getting 20 some gallons a minute out of it.

Q. So the purpose of the development work was, in the 80's, was to do what?

A. To get the rest of the water that was coming out, that was coming down this creek bed.

Q. And how much, after the development work was done in the '80's, how much water was available, was captured in the North Emery Water Users system from Birch Springs?

A. Well, when it was all said and done all we really captured was 90 some gallons a minute.

MR. CHRISTENSEN: In addition?

THE WITNESS: Yes.

MR. LAURISKI: I'm confused a little. When we were talking about Exhibit 3, we talked about the development being capable of putting out 200 gallons. When you finished, the flow went to 200 gallons per minute.

THE WITNESS: When we was developing it we bucketed the places where we come right out of the ledges and we was bucketing 200 gallons a minute.

MR. LAURISKI: So the collection of everything?

THE WITNESS: That was collection of one and two of those, one and two, on the back end. One of them was two hundred something and one was around 100 some gallons. That was when they put the pipe in and we had -- there was more water then, but that's what I was getting out of the buckets.

MR. LAURISKI: That was in 1983, '84?

THE WITNESS: Yes.

MS. LEVER: How much were you getting out after the pipeline was put in?

THE WITNESS: We was only getting 70 some to 90 some gallons a minute.

MS. LEVER: After the work was done you were getting about 90?

THE WITNESS: Yes.

MR. SMITH: I move for admission of Exhibits 3, 4 and 5.

MR. HANSEN: Object to the first page of Exhibit 5, the checks, on the grounds of relevance. I think the fact they did development work is relevant, but whether or not they paid for it or who they paid the money to is not relevant.

MR. LAURISKI: I'll allow the exhibits, and I think that the first page of Exhibit 5 is just to indicate that they actually had the work done at Birch Springs, and we'll just accredit whatever weight is given to the merits of this case.

MR. HANSEN: Okay.

MR. SMITH: That's all the questions I have for Mr. Allred.

MR. MITCHELL: Could I get clarification?

MR. APPEL: I have no questions.

MR. MITCHELL: The checks on Exhibit 5 are dated 1984. Do you think you would have written those checks in the same year in which you did the work?

THE WITNESS: I'm sure.

MR. MITCHELL: So 1984 is probably likely the year in which it was done?

THE WITNESS: Yes.

MR. MITCHELL: And the final page of this exhibit, the hand drawing, do you know who did the hand drawing?

THE WITNESS: I did some and Gary Larsen did some. I don't know who did this one for sure. He was the manager we had at the time.

MR. LAURISKI: When was this? Was this also

Q. Okay. And are you on any boards or do you have any position on any boards in your area?

A. Yes. I'm on the Board of the Huntington/Cleveland Irrigation Company.

Q. Okay. And it's my understanding Huntington/Cleveland Irrigation Company is the holder of the water rights for the water that issues from both Birch Spring and Big Bear Canyon spring?

A. Yes, that's right.

Q. And it's also my understanding you have had a lot of opportunity to observe particularly Birch Spring; is that correct?

A. Yes, all our life we have been cattling, I've seen the springs all my life.

Q. And you say all your life, about what period of time are we talking about?

A. Oh, I was probably like 10 years old before I could remember, you know, doing too much about it. The Birch Spring in particular is right on top of the hill which we call the Bear Canyon hill. We used to truck cattle up there in an old truck and it was hot, and my job was to dip water out of the spring to cool the old truck off with.

Q. Okay. And when you were starting -- I should have asked how old you were and we could figure it out.

Tell us when you were 10 years old, what year was that?

A. 1949.

Q. And so you'd dip water out of Birch Spring to put in the truck; is that right?

A. Yes.

Q. And could you give an estimation of how much water you saw in Birch Spring during your visits there, and if it changed, let's talk about the changes, but if it stayed constant, give an estimation?

A. I don't know that it ever changed.

MR. HANSEN: Objection, lack of foundation. Unless he took measurements to quantify, I don't think he has any personal knowledge to testify.

MR. LAURISKI: You can go ahead Mr. McElpragk, and we'll consider the objection.

THE WITNESS: I would guess, and my guess would probably be 75 gallons a minute.

BY MR. SMITH:

Q. That's based on how big of a stream? Can you describe what kind of stream you saw coming out of Birch Springs?

A. Well, the only thing I could relate to is pump water. I have one pump I use quite a bit that runs 200 gallon a minute and we're out another pump that run 150 gallon a minute. And just what I was basing it on, trying to guess how big that stream was compared to what these pumps out there --

MR. HANSEN: I object and move to strike the testimony. This establishes he's speculating.

MR. LAURISKI: His testimony with respect to the flows out of the Birch Springs?

MR. HANSEN: That's correct.

MR. LAURISKI: Proceed, we'll consider the objection.

BY MR. SMITH:

Q. And so you visited Birch Springs about how many times a year, from 1949 on?

A. Oh, would be four or five times in the spring and probably two or three in the fall, plus -- gosh, we see it all summer long really.

Q. And this was every year from '49 until the time that Birch Springs was developed?

A. Yes.

Q. Ever any times when you saw the Birch Spring just was dry?

A. No, no I never did see it dry.

Q. Did it have approximately the same flow every year?

A. I would think so. As far as I know, I never did notice no change in it anyway.

Q. Okay. How about the spring in Big Bear Canyon, did you have an opportunity --

MR. LAURISKI: Can I stop you for a minute? When you talk about no change, Mr. McElpragk, what time frames are we talking about here from, 1949 to 1994, or?

THE WITNESS: No, I'm talking from '49 to probably '70, through that area.

MR. HANSEN: I object and move to strike on the same basis.

MR. LAURISKI: Go ahead.

MR. SMITH: And the reason it ends in the '70's, that's about when that spring was developed and obviously the flow changed when the development work went into the spring?

A. Yes.

Q. Okay. Moving to Big Bear Canyon springs, did you have an opportunity to observe that spring?

A. Yes, I did.

Q. Was it under the same circumstances as you described for Birch Springs?

A. No, no. The only reason I observed that spring, I used to go up with a kid by the name of Derrick (sic) Rolly, Darrell Rolly was his dad and he took care of the Huntington water. He was a city why. He immediately commented he had never seen anything like that before. We had a lot of water coming out of the cliffs and freezing on the outside that we had never seen before.

MR. LAURISKI: What year was this?

THE WITNESS: This was in 1990 and 1991. First started seeing it probably in December of 1990, and went on in though 1991.

We started investigating that, and we saw some changes in some of the chemical characteristics of our spring. We didn't, at that time, notice any flow differences, but looking back at it now, we can see they were impacting on the flow of the spring. And what we eventually found out was that Co-op mine was discharging mine water back into the old workings of the old mine.

MR. HANSEN: Objection. Lack of foundation, no personal knowledge.

MR. LAURISKI: I'll note the objection, Mr. Hansen.

THE WITNESS: We have prepared some information showing the water quality, how it was affected during that time period. And if you'd like I can give that to you now.

MR. APPEL: That's the last question I have for this witness at this point in time. I'll refer him to Mr. Smith at this point for exhibits.

MR. LAURISKI: All right.

BY MR. SMITH:

Q. Mr. Leamaster, I want to show you what's been marked as Exhibit 13 and Exhibit 14. And I'll ask you to tell me if you can identify Exhibit 13 and 14.

A. Yes, I can. These are photographs that have been put together in the area immediately up canyon from our springs. These would be looking up Bear Canyon towards Bear Canyon mine, and they were taken to show the ice formation on the cliffs above our springs. Our spring would be about in the center of Exhibit 13, and the Bear Canyon mine would be to your right on up the canyon. Again, these were taken in the winter of 1990 and 1991.

Q. Do these photographs accurately depict what you saw at that time?

A. Yes, they do.

Q. And I would take it 13 would be a larger shot and 14 would be a close up of what's depicted in 13?

A. That's correct. I think 13, we took several photographs and then put those together to get a whole -- I guess you would call it a mosaic of the canyon area. 14 is a closer view with the ice formation.

MR. SMITH: I move for admission of Exhibits 13 and 14.

MR. LAURISKI: Mr. Hansen?

MR. HANSEN: No objection.

MR. MITCHELL: No objection.

MR. LAURISKI: Okay.

MR. HANSEN: Except on relevance.

MR. MITCHELL: Except on relevance.

MR. LAURISKI: Okay.

BY MR. SMITH:

Q. I'd like to show you a document that's been marked as Exhibit -- a 4 page document marked as Exhibit 18, and ask if you can identify Exhibit 18 for the Board?

A. Yes, I can. This is information that was developed by me in our office, concerning water quality from the Big Bear Springs.

MR. LAURISKI: Can you hold on for a second Mr. Smith, I think we're having trouble finding them.

MS. BROWN: They were included, Mr. Chairman, in your files this morning.

MR. LAURISKI: This morning?

Okay.

THE WITNESS: The first page of that document is basically a data summary of information that we have on water quality. The first tests we found were in 1971, and it goes up through June of 1994. We have basically summarized the information that we have in our file showing water quality through that time period.

If you turn to the second page of that -- I'm not sure which one you have second. Is it marked calcium concentration on the left side? Okay. What we have done here is graphically plotted out some of the parameters versus time, and the time period we're talking about that we're concerned about occurred in 1990, late 1990, and through the early part of 1991. You'll notice we have one high spike in that area of calcium concentration that occurred in February of '91. And in general, we're a little bit higher in calcium concentration in that area.

If you turn to the other exhibit now, the next page, it's on the left hand side, it says total dissolved solids in milligrams per liter. And you'll notice a very distinct rise in TDS concentration, starting in like January of 1991, and persisting later on into 1991, probably into July or August. And then we back off to more close to the average.

And then the last page of that exhibit plots sulfate concentration again against time, and there you'll see a marked differential in the increase during that same time period in early 1991 into say July or August of 1991.

We felt that these occurrences were related to the ice flow on the ledges, that our spring was being affected by something that was going on in the mine.

MR. HANSEN: Objection to the statement, lack of foundation, no personal knowledge.

MR. MITCHELL: Can I just briefly voir dire this witness with regard to the exhibits? I think we can short cut a lot.

MR. SMITH: Okay.

BY MR. MITCHELL:

Q. Mr. Leamaster, with regard to the exhibits showing pictures of ice on rock in what you believe was about '90, '91, in Exhibit 18, you believe there was a connection between the ice on the surface, and the change in concentration of materials measured for in 1991; is that a fair statement?

A. Yes, I do. I think there was.

Q. And not only do you believe there was a connection between those two events, but you believe there was a connection between something going on at the mine in 1991?

MR. HANSEN: I object to any answers he's giving to the extent they call for expert testimony.

MR. MITCHELL: Right, I just --

MR. HANSEN: If he's giving his lay opinion --

MR. MITCHELL: I just want to know what he thinks. Do you think that?

THE WITNESS: In my opinion, I think there was a connection.

MR. MITCHELL: Okay.

Q. And because you believe that, have you retained an expert to try and help you figure out what's going on; is that right?

A. That's correct.

Q. And you aren't trying to tell the Board you have personal knowledge of what exactly happened, but you were worried and you believed it was appropriate to hire an expert; is that right?

A. That's correct.

Q. And the expert has his opinion as to what happened?

A. That's correct.

Q. Is that a fair statement?

A. Yes.

Q. But if you can't do any more than say because of what you believe were one, an event you observed of ice on rock; two, measurements you took, and your interpretation of those measurements; and three, what you believe was going on in the mine, you believe there's a connection?

A. That's correct.

Q. But you don't have anything you can point to of our own personal knowledge of that time other than what you may have learned from your expert; is that a fair statement?

A. Yes. Although we have been also given some information from DOGM, not directly from the mining company, but from DOGM that also --

Q. From the records filed with DOGM as a requirement of their permit?

A. That also indicated there was a problem.

Q. What time would that have been filed with the Board of Oil, Gas and Mining?

A. It didn't come until later, probably a year, year and-a-half after these events occurred.

Q. Okay. Is that something that you've raised, you've been concerned about, talked about before with the Board of Oil, Gas and Mining?

A. Yes.

Q. Okay. And you've raised your concerns, about the information that you believe was in the Division's records, with it?

A. Yes. Division of Oil, Gas and Mining has not had this information until now. They have had parts of it, but not all of this.

Q. Of your water monitoring?

A. Yes.

Q. Okay. So, what you're saying is that as of today would be the first time the technical staff of the Division of Oil, Gas and Mining would have had the data as presented?

A. That's correct.

Q. In Exhibit 18?

A. Yes.

MR. MITCHELL: Thank you.

MR. LAURISKI: Okay. Your objection is noted, Mr. Hansen.

BY MR. SMITH:

Q. Mr. Leamaster, this Exhibit 18, is that a compilation of records and data collected by your company?

A. Yes, and it also includes some data that has been collected by Co-op mining and they have submitted that to us.

Q. Okay. And it's accurate to the best of your knowledge?

A. Yes, it is.

MR. SMITH: We move to admit Exhibit 18.

MR. HANSEN: No objection.

MR. LAURISKI: Mr. Mitchell?

researched documents, provided by other mining companies in the region, on file with the Division of Oil, Gas and Mining, and otherwise acquired.

Q. Okay. And could you describe which documents provided by the respondent that you've had a chance to review?

A. Well, I've studied all of the documents that they have submitted to the Division of Oil, Gas and Mining in making application for their permitting since I've become involved. And that's included studies their consultants done for them, EarthFax. And I've also studied their submittals here for this hearing, in consideration of their request to be permitted for the Tank Seam coal mining.

Q. Okay.

A. This also included research of U.S. Geological Survey studies that have been done in this area and adjacent areas.

Q. Okay. Since we're not all geologists or hydrologists, and specifically not me, would you like to take a few minutes and kind of explain the general hydrology, geological features of this area that are specifically pertinent to your testimony today? There may be some exhibits here that we want to refer to.

A. Yes, I'd be glad to do that. You already know where the mine is located and the springs are located, I believe, from the previous testimony that's been given.

MR. HANSEN: Excuse me, could we have the witness hold the exhibit back far enough so I can see it as well, please.

THE WITNESS: Yes, I'm sorry.

MR. SMITH: This is also one of the exhibits in your packet.

THE WITNESS: This is a blow up of one of the exhibits.

MR. LAURISKI: Number 9.

MR. SMITH: Thank you, Exhibit number 9.

A. What I would like to emphasize is that the tank coal mining seam is merely a segment of an overall hydrologic system that exists throughout this whole area. And in some ways you might liken it to one piece of a jigsaw puzzle you would lay on the table. To take one piece of that puzzle and try to determine what the total picture is, is greatly restrictive. By taking that piece and fitting it in with the other data or other pieces of the puzzle, then you get a clear picture, and that's what I'd like to emphasize to you. As I say, the Tank Seam is only part of this overall geologic and hydrologic system.

What we have, and I depicted on this generalized outline, is we have a regional aquifer that extends throughout this whole area. Generally that aquifer consists of the lower previous geologic formations that are present in the area that will allow groundwater to enter in to them and be stored, and to be released from them.

The lower section of the geologic section that allows a regional aquifer to be developed within them, is the Blackhawk Formation, which contains the coal seams that we're talking about. The Tank Seam is in the upper part of it, and the Blind Canyon seam or Bear Canyon seam is the one that's presently being mined, the Co-op mine, and it's in the lower part of the Blackhawk Formation.

Underlying the Blackhawk Formation, we have a sequence of sandstones that have some inner beds of shale. This is known as a Star Point Sandstone Formation. And it rests directly upon a very thick shale formation known as the Mancos Shale, several thousand feet, it's quite impervious. So that acts as a floor to hold up the groundwater above that point within these pervious members.

The Star Point Sandstone has three members, sandstone members that are pervious and will receive and store groundwater. The upper member is the Spring

Canyon, the middle member is the Storrs, the lower member is the Panther member. And it's from the Panther member -- the base of this system, this hydrologic system, that the Birch Spring and the Big Bear Spring issues forth. The coal mine, Co-op's coal mine as presently operating has intercepted this regional aquifer that is within both the Star Points -- the Star Point sandstone and the Blackhawk Formation. So, the regional aquifer has a potentiometric surface or a sloping surface very much like the land surface that extends upward as you get in to the higher mountains.

And at the discharge point where the springs are, the potentiometric surface is very low, and the formation directly above it is not saturated. But as you get back northward into the mountain range, the Gentry Mountain Range to the north, THEN you have a thicker saturated section, and that section actually reaches up into the Blackhawk Formation which contains the coal beds. So when they mine the coal they intercept the groundwater.

Now, there are conditions here that make this groundwater not only able to flow laterally through the pervious sandstone beds, but it can also be transmitted vertically down through the strata, and it's due to extensive faulting that's occurred in this area. These are tensional faults, formed by tensional forces pulling apart the rock formation and allowing cracks or joints to be formed, and where there's actually been movement or displacement along the joints, that's a fault.

You have openings that are developed vertically. These are near vertical faults that trend north and south. The Big Bear Spring and the Birch Spring, along with the Co-op mine, are located directly between two very prominent faults, as I show here on this sketch. One immediately to the east which has been called the Bear Canyon fault, that's at least 100 feet of displacement along it. And to the west, which is west of the Birch Springs, it extends northward also, as does the Bear Canyon fault, known as the Pleasant Valley fault. These extends for miles northward and southward. And in between those two faults is a segment of the earth's crust that's also faulted with less prominent faults. The Big Bear Spring discharges from three prominent joints at the south end of a prominent fault, just west of the Bear Canyon fault. The Birch Spring discharges along the very prominent fault which ties in with the Blind Canyon fault which is adjacent immediately on the west edge of the Co-op mining operations. So, and they are directly down gradient, these springs are directly down gradient to the south of the Co-op mining operation.

Gentry Mountain area extends to the north with higher elevations, and that's where a lot of the recharge comes from that enters into that regional aquifer and discharges into the springs. I'd like to refer also to this cross-section, which is generalized again, through this area. The heavy black line is actually the surface of the ground, so, again, you have the Mancos Shale as I stated before which underlies the whole area which is impervious. And you have the Star Point sandstone immediately on top of it with the three members I've mentioned, and immediately above that you have the Blackhawk Formation, with the prominent coal beds within it.

And then above that you have other formations, which also receive infield trading water from precipitation and run off, that eventually works its way down and gets into the bottom of the hydrologic system or the regional aquifer, which again is comprised of both the Blackhawk Formation and the Star Point Sandstone. This has been proven and shown by several studies conducted by the U.S. Geological survey not only in this area, but the area to the south, the area to the north.

Referring to this exhibit, which is whatever number.

Q. Excuse me, this is, I believe, Exhibit 11.

A. Okay. This is taken from one of the U.S. Geological studies and shows, depicts this system I've just explained to you.

MR. HANSEN: Objection, hasn't been established it does show the conditions as it exists in the area that's being mined. What we are looking at is a very general diagrammatic cross-section that bears no necessary relationship to the specific conditions found in the areas that Co-op is mining. In particular, this Exhibit doesn't show the Tank Seam at all, and shows no relationship between where the water may be coming from and where the Tank Seam is, and what effect mining in the Tank Seam may have, and I object to this exhibit on that basis.

MR. SMITH: Mr. Chairman, we're trying to at least establish kind of the basic geology which this testimony is based on. This exhibit is taken from a USGS study of that area of the coal field. The Wasatch Plateau coal field. It's not being offered, hasn't been offered yet. I don't even need to talk to an objection until I actually try to offer it into evidence, but it will be offered just as a learned treatise that shows helpful information as to the general geology and hydrology of this area of the state.

MR. HANSEN: Again, even though it shows general geology of the areas, unless it shows specific geology of the specific area we're looking at, including the Tank Seam, it is in fact not helpful.

THE WITNESS: Can I show the specifics?

MR. LAURISKI: Well, let me -- we'll note the objection, and we'll consider what weight to give the exhibit if in fact it is offered into evidence relative to its applicability to the tank in the Blind Canyon seam. Go ahead.

THE WITNESS: All right.

It's true that it doesn't contain all of the detail, but it's hard to put on a chart in this fashion of display, every detail. But it does show sufficient to show the interrelationship of the regional aquifer from which the two springs discharge, subject springs discharge, and the existing coal bed that's being mined and the Tank Seam that's being proposed to be mined. This area in blue --

MR. HANSEN: I object, this document does not show where these springs are being discharged from, doesn't show the springs at all.

MR. SMITH: Mr. Chairman, if the witness could finish the answers before the objections are interposed, I think this would go a lot better.

MR. HANSEN: The time the objection is to be made is at the time.

MR. LAURISKI: I'll consider it a continuing objection to this exhibit and to his testimony.

MR. HANSEN: Thank you.

THE WITNESS: Perhaps I could refer to an exhibit that has been already accepted, that is similar to this. That shows the actual springs, if I -- that shows the actual springs. This Exhibit D depicts very much the same as this other exhibit, but it's in three dimension, which I've prepared Exhibit D and the others.

MR. SMITH: That's Exhibit 8.

THE WITNESS: Eight, your eight looks like a D. But anyway, it does then -- well, I guess it's still another exhibit that I've actually named the springs on. But let me continue.

MR. HANSEN: Again, I would point out that Exhibit 8, according to my notes, has not been discussed or offered or admitted.

MR. LAURISKI: He has moved off of Exhibit 8 and gone back to Exhibit 11, so I think we can move forward here.

THE WITNESS: Okay. The thick blue section represents the regional aquifer which is at the base of hydrologic system and extends over several miles, wide area. All of the coal mines in the area, actually as they develop back into the mountain further into their operations, they intercept this aquifer, including the Co-op mine. At the base of that aquifer, there is spillings that takes place. The water quality in this aquifer is high quality and circulation and movement of water from the area of recharge to the point of discharge. Birch Springs and Big Bear Spring are two of the points of discharge of that regional aquifer.

This black bed right here, represents the lower beds in the Castlegate Formation of the Blackhawk Formation, such as the Blind Canyon seam that's presently being mined in the Co-op mine. This seam right here, this black one here, would depict the Tank Seam that's proposed to be mined, and you can see that in this example no appreciable groundwater exists in the Tank Seam. There may be a little perched water that's worked its way down through the vertical fracture system and a small amount may be encountered. But below the Tank Seam you have the principal aquifer and the potentiometric surface sloping towards the canyon bottom, as I mentioned, as depicted on this cross-section. So, the proposal by Co-op Mining Company to mine the Tank Seam, not only involves the Tank Seam itself, but they need to have an interconnection as so stated in their proposal.

After they remove the coal from the face, they're going to move it down a ramp into the present workings where the Blind Canyon seam is being mined now. So they are going to affect this interval between the Blind Canyon seam and the Tank Seam. Plus, as they mine this Tank Seam and introduce whatever contaminants either in the subsurface or on roadways, such as salt applied in the winter, it's going to be able to be conveyed downward by any water, whether it's precipitation falling on the surface up here, or it exists within the ground, as it moves its way downward to the base of the hydrologic system. Whatever contaminants may be introduced, that water can convey it downward over time.

The other aspect of it is, as they mine this seam they are removing a support within the geologic section. That will later cause collapsing of overlying beds and induce increased jointing and fracturing for any infield trading water that may fall to the surface of the ground. That water too will work its way on down until it get to the bottom of the system, the regional aquifer.

So, it too can introduce contaminants into the system in that manner. Besides that, as they continue to use the lower workings to take out the coal of the mining operation in the Tank Seam, they will continue to intercept and drain this regional aquifer of part of its water and bring it out to the surface and dump it into the surface drainage of Bear Canyon where it can't get back in to recharge or supply the springs. The springs are receiving water out of the storage of this regional aquifer.

If you consider what Co-op has reported, they reported that they have encountered approximately 500 gallons a minute of water as they continue their operations. They say they are removing about 300 gallons a minute out of the subsurface and dumping it into the surface. That's nearly half a million gallons of water a day that they are subtracting and removing out of this storage. It will not be available over time to supply these springs.

The movement of this groundwater is very slow. It's not like water in a river. It's moving very slow through this rock. From the pumping in tests that have been conducted both by EarthFax for Co-op, and by Plateau Mining Company, the rate of flow is only about a 10th of a foot per day or less.

If you intercept this water by your mining operations, and then convey it such as was originally done prior to 1991, and convey it into the south end of the mine workings, then you've interrupted the natural rate of flow through that section. And as the -- let's see. Could I -- as the photographs depicted that were earlier shown, I took these photos myself in the winter of 1990 and '91, it's Exhibits 13 and 14, that groundwater, here's the top, very top of Exhibit 14, that bed is the collapsed coal bed that's being mined in the present mine. It's been set on fire naturally, and then the rock has collapsed. And you can see that's where the water is discharging from, is the base of that Blackhawk Formation. And it's spewing down over the face of the cliffs. They're interbedded shales in this Star Point section spilling over that contain dissolved solids. So besides the dissolved solids that are being conveyed out of the mine, which in those days prior to 1991, they were using calcium sulfate or gypsum dust to suppress the coal dust. Besides dissolving the water and bringing it out as this water flows down over the face of these cliffs, it picks up additional dissolved solids. Some of that water reentered the fracture system and becomes part of the recharge to these mines or these springs that we're talking about, both Big Bear and Birch Spring.

So that's how the interrelationship is of one strata to another and how the groundwater moves down from one to the other. It all moves down towards this basil regional aquifer.

Q. Before we get to the next chart, maybe we can -- let me ask you this question, Mr. Montgomery. Is Exhibit 11, which is the one we have just been looking at, is that an accurate representation of the geology of the area around the Bear Canyon mine?

A. Yes, it has the formation named along the margin.

Q. I move for admission of Exhibit 11.

MR. LAURISKI: Mr. Hansen?

MR. HANSEN: I have no objection as too what it shows. I do have some objections as to the comments that have been made and I've made most of those. But as for what it shows on its face, I have no objection.

MR. LAURISKI: Mr. Mitchell?

MR. MITCHELL: Let me clarify. This is introduced for illustrative purposes only to show a generalized cross section of the geology and hydrology of the Wasatch Plateau?

MR. SMITH: Yes.

MR. MITCHELL: Subject to that limitation, I have no area because all groundwater reaching from precipitation, either direct infiltration or runoff that later infiltrates in to the subsurface, that's where groundwater originates, comes from. So, the changes in precipitation certainly have an influence on the springs, how they respond. And where you have a spring such as Little Bear Spring that has not been impacted by mining, it represents, you might say, the natural conditions unaffected, except for changes in precipitation.

Here on this chart, Exhibit 15, comparative flow chart from 1980 to 1994, of the three springs stated plus the precipitation. Precipitation is shown in the heavy blue line. Here you can see on the left side the scale is in tenths of inches for the precipitation. This is obtained from the Red Pine station which is just across the canyon from the two springs of concern.

And it was provided by the Department of Agriculture, the data for that. The red line depicts the flows by year across the bottom of Little Bear Spring. And you can see how that spring has fluctuated over that number of years from 1980 to 1994. There has been some ups and downs, but in general you can see the trend like thus, as I place the marker through that area.

In comparison, the green line depicts Big Bear Spring flows. You can see that there was a high in 1980 of about 270 gallons per minute. Then there was a drop down to about 180 gallons a minute. Then all of a sudden there was an abrupt rise and a hump, anomalous hump in the flows of Big Bear Spring.

MR. HANSEN: I object to testimony and characterization of what that exhibit shows. It shows what it says, and speaks for itself. We can all look at it and see what it says and don't need opinions as to what it says.

MR. LAURISKI: Well, Mr. Hansen I think Mr. Montgomery's been offered as an expert witness in this case, and I think that opinions are appropriate for experts.

MR. HANSEN: My point is, it doesn't take expert testimony to tell what a diagram shows. It shows what it shows.

MR. LAURISKI: It also leaves open a lot of question that perhaps either the Board has, at least I know I have some, and I'd like the opportunity to hear from Mr. Montgomery relative to what he thinks causes the anomalies or causes the decline in the curve with respect to these different springs. And I think it's appropriate for him to offer that into evidence.

other USGS reports that, to tie in, I think the only problem was with whether the Little Bear had any relevance. I didn't hear any objection to either the precipitation or the flows of the two other springs. I move for admission of Exhibit 15. I'd also like Mr. Montgomery to identify -- I'll do that and then move on.

MR. LAURISKI: We have the objections listed on Exhibit 15, and I'll note those objections, and we'll go ahead and take the evidence and consider the objection relative to the --

MR. MITCHELL: So is it fair to say at this time on 15, you're reserving whether you're going to take it or not?

MR. LAURISKI: That's correct.

MR. MITCHELL: And there will be an opportunity to cross examine Mr. Montgomery with regard to that exhibit further?

MR. LAURISKI: Yes, you will.

MR. SMITH: I then would like to have Mr. Montgomery identify Exhibit 16, which is a flow of just the, or chart of just the precipitation for Big Bear and Big Bear Springs for a shorter period of time, more detailed breaking up of the year from 1989 to 1994. And I'll have him identify that so we can get that moved for admission.

THE WITNESS: This shows the same as the other diagram on the flows except it covers a shorter period from 1980 to 1994 with an amplification of the scale on the left of gallons per minute. And it shows that the precipitation is quite steady through this area. Although you have areas of ups and downs, you can average a line quite steady through it. But the flows of Birch Springs were anomalously high, up a hundred gallons per minute, dropped and have continued to drop. And that drop is very pronounced on this scale, and they never have come back up again over those years.

The Big Bear Spring is shown in the green, and again, if you average a line to the highs and lows, there's a gradual decline from '89 through '94 of the flows.

MR. SMITH: I move for admission of Exhibit 16.

MR. HANSEN: I object on the grounds of relevance. Mr. Montgomery did testify that the water in this water table is moving at an extremely slow rate. I believe he testified one tenth of a foot per day was the flow rate in this water table. At that rate it moves less than approximately 36 feet per year. Mr. Montgomery also testified that there is at least a half a mile between Big Bear Spring and the portal of the current mining operation. That is what, 2600 feet. It would take in excess of 20 years for water to flow at that rate from the mining operation down to the spring. Given that 20 year discrepancy rate, trying to compare flow rates a month apart is totally irrelevant.

MR. MITCHELL: I also have a concern with the lack of scale with regard to precipitation. The precipitation is measured in one tenth of an inch. I don't know what that means on this, next to gallons per minute plotted across this. It's visually appealing, but I can't do anything with it.

MR. LAURISKI: I have noted both objections like Exhibit 15, and we're going to reserve a decision on the objection so you'll have an opportunity to cross examine on the relevance of these two exhibits. Mr. Smith.

MR. SMITH: Thank you.

Q. I'd like to turn your attention now, Mr. Montgomery, to what's been submitted to the Board by Co-op Mining Company as their Exhibit B, which is certain pages out of the technical analysis prepared for the Tank Seam, significant revision prepared by the Division. There are certain pages I specifically would like to turn your attention to. What's listed as page 21, which is the second page of Exhibit B, and I'd further focus your attention on the second or last paragraph on that page, under the heading of groundwater.

And maybe the easiest way is I can read -- I'll read for the record this paragraph, and then have you testify as to whether you agree with this conclusion, or disagree with this conclusion that was reached by the Division on the significant revision that's before us today.

MR. CHRISTENSEN: What are we looking for?

MR. SMITH: You're looking for -- Co-op Mining Company has submitted their exhibits and rather than using numbers they gave them letters. It's their Exhibit B.

MR. CHRISTENSEN: Okay, thank you.

MR. SMITH: Second page of that. The top of page it says page 21. They've excerpted certain pages, I guess, that are relevant and submitted them today, or submitted them for the hearing today. And when everyone finds that I'll be happy to, like I said, I'll read that and then you can, Mr. Montgomery, testify as to whether you agree with the conclusion or disagree. And if you disagree, give us the reasons for your disagreement.

I'll begin with the conclusion in that last paragraph. It says, "Although a regional aquifer (termed the Star Point - Blackhawk aquifer by Danielson, et. al., 1981,) has been designated for the area, in-mine drilling and aquifer testing conducted for this study area indicate that three aquifers within the Star Point sandstone have individual static water levels. Further, in the southern most hole (DH-3) -- I assume that's for drill hole three -- shown on Plate 2, PAP, none of the three aquifers are fully saturated. This fact indicates each of the units have a separate and distinct water levels. The springs issue from the bottom of the Panther Tongue in (417 to 433 feet below the Blackhawk Formation contact with the Star Point Sandstone.) Therefore, Birch Springs and Big Bear Springs are hydrologically isolated from the impacts of mining in the Blackhawk Formation by the presence of two Mancos Tongues in the Star Point Sandstone."

A. I have no argument with the fact that separate water levels are measured in the three separate tongues of the Star Point Sandstone. And that part of the sandstone members were not fully saturated. As I depicted earlier, the mine intercepts the groundwater table or the potentiometric surface of this regional aquifer. So what you've got, you've got groundwater that is trying to move laterally within the pervious three sandstone units. And you're -- you can easily get different water levels, successfully deeper water levels from the upper one to the bottom one because of some interpolation of shale beds. But this does not preclude this groundwater from moving downward through joints and faults to the lower most member. That's exactly what's happening.

If this was not so, if this water could not move downward, it would move laterally out to the face of the cliffs and discharge down the face of the cliffs, which it never has done naturally. 300 to 500 gallons a minute is a lot of water, that's a half a million gallons a day. And you don't have that just come to the face of the cliffs and evaporate. It has to flow somewhere. And it goes downwards through the fracture system.

BY MR. SMITH:

Q. I'll read the next paragraph and have you similarly comment on the next paragraph.

"Areas of encountered groundwater within the mine are fractures which drain over a period of several months as the mine advances northward. This indicates a high degree of hydraulic interconnection through fractures in the portion of the Blackhawk Formation which overlies the mine. Inflows in the north end of the North Main and Second East entries are through roof bolt holes and hairline fractures which are presumed to drain overlaying perched aquifers in the Blackhawk Formation. The current rate of discharge from the mine is approximately 300 gallons per minute."

A. Well, the water is moving downward into this regional aquifer as I've explained before. You'll find it in all degrees of saturation. The only place you'll see it moving is through a joint system, or such as was indicated, you could drill a hole up and intercept a joint or a bedding plain that's conveying the water, and get water to come out of it.

There's other members that perhaps are not saturated. Keep in mind that we're working, the Co-op mine is working both out of the regional aquifer at the south end, gradually northward to where it penetrates, and as it goes farther northward, it's penetrating it further with a higher head and more pressure there so more flow will come in to the mine as they go northward.

So, the chemical quality in the mine should be higher than water that was discharged by man out to the face of the cliffs, and then run down over the face of the cliffs which had both been in contact with calcium sulfate rock dust in the mine, as well as shale beds exposed across, or across the ends of the shale beds that are exposed to the cliff face. So you are bound to get more sulfates in the water that is traveling through that interval.

The comments made a moment ago by Mr. Hansen about this water traveling at that rate, not all of it is traveling under ground, some of it has been spewed out and spilled down the face, and the water we're talking about was sampled back in 1991. That's the figures we're talking about, both from Co-op's studies as well as the data I've supplied to you. It was back then when we had this anomalous high, 1990 and '91.

Q. I'll continue and read the next paragraph and ask you to simply comment on this conclusion of the Division.

"Big Bear Springs Birch Springs in the vicinity of the Bear Canyon mine issue from joints at the contact between the Panther Tongue and the Mancos Shale. The majority of water inflows in the mine are through bolt holes and fractures draining perched aquifers in the Blackhawk and an indeterminate amount of interception of water from the floor in the area of the Second East entries. The review of water source information, the graphical tracking of precipitation versus flow, the testing of the spring water and mine water quality for tritium dating, analysis of water quality chemical data using Stiff and Piper diagrams, and the known presence of three separate a piezometric surfaces based on drilling in the Spring Canyon, Storrs, and Panther Tongues of the Star Point Sandstone, leads to a conclusion of no significant material damage to the Hydrologic Balance outside the permit area."

A. Well, I believe that's a wrong presumption. And as I just stated before, there are differences that have occurred by the mining operations on this aquifer system, beyond what was naturally occurring before with regard to the tritium content. Tritium is a daughter product of radiation from open air bomb testing. It has a short half life of about 14 years. In other words, water that has been within the subsurface for a long period of time would have very low tritium content, specifically before the testing, the atomic bomb testing.

But surface exposures and water on the surface is bound to have higher tritium content. Once that water was discharged out of the face, of the cliff face -- the mining operations, it flowed down over the face and could easily have picked up more tritium content before some of it reinfiltrated back into the exposed Star Point Sandstone which is at the face where this water is infiltrating back into the recharge of the springs.

Q. Okay. We'll do one more paragraph, it's the next paragraph down.

"Co-op Mining Company has drilled 8 exploratory drill holes into the Tank Seam, (page 2-13, Appendix 7-J, PAP). All were dry except one which flows at .5 GPM (drilled up from the mine workings in the Blind Canyon Seam). The inflows into the Tank Seam are expected to be much less than those encountered in the Blind Canyon Seam. Stratigraphically, the Tank Seam is 250 feet above the Blind Canyon Seam and therefore would tend to be drier and not expected to have the groundwater inflows found in lower coal seams (i.e., the Blind Canyon and the Hiawatha Seams). There has been no continuous water quality problems associated with mine water discharge at the Bear Canyon Mine and therefore it is not expected to change in the future, although it will be closely watched for any long term trends."

A. I have no objection to the earlier statements there, as to the facts presented there. But the conclusion in the last sentence is erroneous. There have been water quality problems, we have pointed those out to you, associated with discharge of water at the Bear Creek mine. Furthermore, as the Tank Seam is mined, whatever water is encountered will be dropped into the present workings. There's proposed to be a ramp to remove the coal from the Blind, or I mean the consider those issues, we can do that, or if we need to move forward. What's the Board's pleasure? Mr. Faddies?

MR. FADDIES: Move forward.

MS. ERLER: Move forward.

MR. MITCHELL: So could we have a brief recess to confer with our witnesses?

MR. LAURISKI: Five minutes.

(Whereupon a recess was taken.)

MR. LAURISKI: Mr. Hansen, we're back on the record.

MR. HANSEN: We'll call Kimly Mangum.

KIMLY MANGUM

was duly sworn, was examined and testified as follows:

BY MR. HANSEN:

Q. Would you state your full name?

A. Kimly, K-i-m-l-y C. Mangum, M-a-n-g-u-m.

Q. And can you tell us where you live and where you are employed?

A. I live at 388 East Boynton Road in Kaysville, Utah. I am employed independently by Mangum Engineering Consultants.

Q. Are you familiar with Huntington Canyon and the Co-op mine area in the canyon particularly?

A. Yes, I am.

Q. Are you aware of when Co-op mine first began mining in Bear Canyon?

A. Operations began 1981.

Q. Were you ever in the canyon area before that time?

A. Yes, I was.

Q. Can you tell us a little bit about the times you were there before Co-op mine began mining?

A. I was there, before Co-op mining began on one particular occasion that I recall, where I went over with a friend and went inside of the mine, in the existing workings that were there. It was in late fall. There was ice inside the mine where water was dripping from the ceiling. There was -- we had to hike up part way. There was ice on the outside on the hills where there was water apparently from springs from the surface.

Q. I'm going to show you my copy of Exhibit 14. That isn't too clear, maybe if we could get the color photograph that was marked, it would show it. Can you identify the area that's shown by Exhibit 14?

A. May I see the color one? This appears to be the cliffs above what is known as Big Bear Spring.

Q. And on this visit that you were just

Q. Now, you say currently you're discharging about 200 gallons per minute out of your mine?

A. Yes.

Q. And that's --

A. Well, let me rephrase that. There's an inflow of about 200, 210 gallons per minute.

Q. How do you know what the inflow is? How do you measure the inflow?

A. What we do is we have a meter that measures the water that's pumped out of the sections where the water's flowing into the mine, and then we also have a meter that meters the water that is discharged.

Q. How much are you discharging from the mine?

A. It's between 100, varies from 185 to 195 gallons. Sometimes it's a little less, depending on how full the sumps are in the mine.

Q. So approximately 200?

A. Close to that, yes.

Q. And how much -- so you're discharging -- so that's excess water you don't need for any use inside the mine?

A. That's correct.

Q. And I assume you're using water that you find in the mine as well; is that around 200 gallons per minute as well?

A. The water that we're using within the mine is around 15, usually about 15 to 20 gallons per minute.

Q. So, I guess then from what you're testifying there's an extreme error in your PHC, that's Exhibit C, that's been submitted by Co-op. Do you have that? Are you familiar with that?

A. Yes, I am. There was, in the original PHC that was submitted for the Blind Canyon Seam, there was an error in the flows. There has since been a correction submitted to the Division to correct that information. An amendment has been submitted.

Q. So on 2-13 there's an error, at least what we've been relying on in this hearing, there's an error in this document?

A. There's an error in the PHC that was approved for the --

MR. HANSEN: I think it's fair, if the witness is going to be testifying about the contents of a document he should be able to review it first.

MR. SMITH: I'm looking at page 2-13, and 2-14 of the PHC that was submitted by Co-op, as one of their hearing exhibits today.

Q. Why don't I read each sentence and you tell me whether that sentence is correct or in error. "Prior to 1991, mine water inflow was small and often --" I'm

A. Yes, I am.

Q. Do you know how long that period of drought has persisted in that area?

A. No, I don't. I moved to the area in 1991, and at that time we were in a drought.

Q. How long do you propose to mine, or does Co-op propose to mine the Tank Seam?

A. The estimated projection of mining in the Tank Seam is about six years.

Q. I'll refer to you as the environmental coordinator, is that correct?

A. Yes.

Q. What plans do you have to reduce contamination to the water moving subsurface below that particular mine, meaning the Tank Seam?

A. So far we haven't found evidence of water in the area of the Tank Seam. The permit does provide for any impacts which may occur to springs in the area. There would be mitigation provided for the replacement of water, or some treatment of that water.

Q. How will you -- I'm sorry?

A. If there were any water affected.

Q. Well, and I understand that that's a statement that's been made in the documents, but what sources do you plan to use to provide water to these people?

MR. HANSEN: I object, that far exceeds the scope of direct.

MR. APPEL: I think we're talking about the PHC and the requirements, and certainly as an element of the law that you're going to apply. The fact that he's an environmental coordinator, they have opened the door to let us examine. We're trying to get to the truth here and it's fairly important.

MR. LAURISKI: Is that question addressed in the PHC?

THE WITNESS: Those stipulations are in an agreement in the current PAP, and in an agreement with Huntington City at the time mining began in Bear Canyon. They're not in this, in the PHC that's been updated. They're not discussed in that because we have found no evidence to indicate that there has been impact due to mining operations.

MR. APPEL: That's dancing around my question. What sources would you use to replace should you find that there is impact, because you recognize we disagree with you on that. People can't disagree if we end up prevailing. What sources will you use to replace?

MR. MITCHELL: I object to that because one, it's not clear he's qualified to provide the answer for the company he consults for. Two, you're referring to an the Division which got us here in the first place.

MR. LAURISKI: We'll take each one of those issues on a case by case basis and see what it is that they're going to offer. But we are concerned by any documents that have been prepared beforehand, knowing that they're going to be used as rebuttal evidence based upon the facts that you've learned from the petitioners in this case, without giving them the opportunity to see what that evidence is going to be in your response to their request to have this case heard.

So with that, we can move forward.

MR. SMITH: Thank you.

BY MR. HANSEN:

Q. Can you tell us the diagram that we're looking at now?

A. This is part of the hydrogeologic evaluation, hydrogeologic evaluation Figure 2-2. It shows really nothing that this picture doesn't.

Q. It's Figure 2-2 in our Exhibit D, located between pages 2-9 and 2-10, immediately following page 2-9.

MR. LAURISKI: Now, would you take us to that again, please. We're at Exhibit D?

MR. HANSEN: Figure 2-2, the fold-out sheet immediately following page 2-9.

MR. LAURISKI: We're with you.

BY MR. HANSEN:

Q. Okay.

A. The data on that figure was used to produce this cross-section which is just easier on the eye, it's not new information, it's just easier to understand in its context of a cross-section. If you'd like to proceed with this one, I can tell the same story. These are the inline drill holes we put in at Co-op. We set a packer at the top of each one of these sandstone tongues, bottomed the hole in the shale which is impermeable, and then slug and bail tests in there, in each one as we proceeded. So we isolated each aquifer as we proceeded. We got separate piezometric surfaces or each of the sandstone togues, separated by the impermeable -- in fact, when you took the shale out of the core and broke it, it was dry. These are all separate aquifers. They've got separate piezometric surfaces.

As far as a regional aquifer is concerned, I think it's a matter of semantics. There's no regional aquifer cutting across the Blackhawk and the Storrs and the Spring Canyon and the Panther as such. It's much more complex than that. And just simply taking a USGS block diagram and pointing to a line that slashes through things, is not really accurate. I don't think it tells the whole story. We've got some very expensive, very good data here to show that things are otherwise. The fact that he piezometric surface actually rises above the shale-- this is the Panther, here is the Panther tongue here -- it's confined, so is the Storrs water, it's confined; so is the Spring Canyon water confined in the furthest north hole. It's unconfined in the furthest south hole. The mountain faces somewhere out here. It's much more easy to understand on that piece of paper, but if you can visualize it we'll be all right.

The fact that these are confined, suggests the recharge for these aquifers is well to the north at a higher elevation, probably in the shattered zone, as we've pointed out in the hydrogeologic evaluation which is north of the Co-op. This is from Brown and Spieker, all data compiled from USGS documents.

Q. I don't want to run afoul of the Board's ruling on this. We have an exhibit included. I don't believe that one was.

A. This is from the hydrogeologic evaluation.

Q. In your revised geologic evaluation?

A. I don't know what was submitted. It's usually held in a pouch in the back.

MR. SMITH: It's probably shown on that map, and that's been admitted. It's an exhibit.

MR. LAURISKI: The Board has no objection if the exhibits are submitted as part of the evidence. What the Board objected to was whether or not you were submitting new evidence that was outside the Board's order of October 7th.

MR. HANSEN: It wasn't new evidence, it was just trying to illustrate the evidence that was already here in a fashion more easy to understand.

MR. HANSEN: It is included in my preliminary exhibits.

MR. LAURISKI: Is this what you were looking at?

THE WITNESS: This is a plate from the hydrogeologic evaluation submitted to the DOGM. Plate number 1, geology and structure map.

MR. MITCHELL: Well, is there an objection to using it?

MR. HANSEN: It is among the exhibits I designated as an exhibit in my September 9th, 1994, designation of exhibits. It is just not on my final exhibit list that was filed last week.

MR. SMITH: Maybe we can shorten this. We have no objection to that map. I don't want to open the door because what Mr. Hansen is alluding to is he submitted and said everything on file at the Division of Oil, Gas and Mining we may use as an exhibit. We all know that's drawers and drawers full of stuff. And then he submitted a list of exhibits which is what we're working off of, which he called his final exhibit list.

As far as that one map, if that's going to speed things up, let's get the map in. But I'm -- obviously we aren't waiving our objection to other things that may be new compilations we haven't seen.

MR. MITCHELL: Let's take them one exhibit at a time.

MR. LAURISKI: Go ahead, Mr. Garr.

THE WITNESS: We've got this groundwater in each of these aquifers is confined by these shales that are here. It's our interpretation that the recharge to this, to these aquifers is not on Gentry Ridge. Gentry Ridge is very narrow, very little flat surface to infiltrate water. It's gonna have runoff, very narrow above the mine. There's an awful lot of recharge going through here. The pressure suggests the recharge is actually to the north up dip and the shattered zone as identified by brown, is a much more likely recharge area. It's more flat, it's a flatter area, it's shattered, it infiltrates much more quickly than a ridge on Gentry Mountain. If I could look at Exhibit 9.

MR. HANSEN: While he's doing that, I believe that's all the testimony that Mr. Garr is going to offer on this Plate 1. We offer it as our Exhibit E.

MR. LAURISKI: Mr. Appel, do you or Mr. Smith have an objection to allowing that to come in as Exhibit E? The map, Mr. Garr, the plate?

MR. APPEL: No.

MR. SMITH: No objection, your Honor -- Mr. Chairman.

MR. LAURISKI: Thank you.

THE WITNESS: Here on Exhibit 9, one thing I noticed with the sense of movement on the Bear Canyon fault, is incorrect. It's actually down on the Bear Canyon side or the mine side, and up on the other side. This is -- we have about 110 feet of movement on it down to the west. It's put forth as a major fault, because as was mentioned earlier, there's another fault that runs through here. Blind Canyon Fault would run somewhere like that. This isn't really to scale either. Birch Springs is actually 800 feet to the west of Blind Canyon Fault.

MR. LAURISKI: When you say "like that" would you describe what "like that" is.

THE WITNESS: I've got this map that will show you where it is. Here's the Blind Canyon fault running through there. Here's the Bear Canyon mine, here's the Bear Canyon fault. Displacement down on the west. Here's the -- Blind Canyon fault here has approximately 220 feet of displacement down on the west. Again, this fault was sort of left off the discussion before, but it could be very significant. Either the Blind Canyon Fault could serve as a conduit to groundwater flow or serve as a barrier to groundwater flow depending on whether it was filled with fault gouge or if it had voids. In either case if groundwater was moving from Co-op into the Blind Canyon Fault, it's either going to be stopped by the gouge, or it's going to act as a conduit that's going to carry the water out. And you're gonna see a spring at the mountain point where that fault daylights. There's no such spring. Yet we go 800 feet further west to Birch Spring which is associated with some joints. I don't think they're connected. I don't see any reason why they would be connected. It should have been included on here though.

Exhibit 10. Exhibit 10 was put forth to show what happens during coal mining the groundwater. Here we have got the water table well above the mine seam. This is all saturated presumably. This is just what happens when you do that with a coal mine and groundwater is above you. The water table is above you. That's not

the case at Co-op at all. And that's shown in this diagram where -- here's the mine seam right here at the floor where these wells take off. Groundwater is below that. It's even below it, if you poke a hole through it and let it come up, it's below the coal seam.

MR. APPEL: For clarification you are talking about the Blind?

THE WITNESS: Yes.

MR. APPEL: Not the Tank Seam.

THE WITNESS: And of course the Tank also because the Tank is 200 plus feet above. If I could show this lovely drawing that would show that very simply, otherwise I have to describe it.

MR. MITCHELL: Would it be helpful for you to use a marker on the blackboard and draw what it is to describe or --

THE WITNESS: I could do that.

MR. MITCHELL: -- illustrate your testimony.

MS. LEVER: Do you want to save it and put it on the white paper?

MR. MITCHELL: It's just for illustrative purposes. (Witness is drawing.)

THE WITNESS: Here's the area, is a view from the north south through Gentry.

MR. LAURISKI: Mr. Garr, we need you to speak up.

THE WITNESS: All right. Here's the Tank Seam and the Blind Canyon Seam. Groundwater in what we have found in the drill holes, going generally like that, there are three different heads and down here Panther actually issues springs.

Q. Both Birch Spring and Big Bear Spring issue out of the Panther?

A. To my knowledge, yes.

The groundwater isn't in the Blind Canyon Seam here, certainly not going to be in the Tank Seam. There's going to be perched water here and there, but that perched water does not contribute to the springs. That's our contention. The reason for that is because of the very small recharge area on that ridge. The fact that we have got the potentiometric surfaces above the confining layers in the north part of the mine, and they're unconfined at the south part of the mine near the outcrop.

Exhibit 15. The idea of using Little Bear Spring as a control, we don't consider to be valid because Little Bear looks like it responds pretty quickly to precipitation, recharge just like that. We're looking at other springs. They could have a year or two lag time between the precipitation event and when it shows up. And in fact we see that in, I believe, Big Bear

Spring. This shows it. We have precipitation here, big flow increase at Big Bear here. That's about a year on that one. We've got some data that would show about two years lag from when you have a real wet year to when it starts showing up as increased flows at Big Bear. I don't know if that was submitted. The point is that to pick out one spring, and use that as a control is not realistic. I think the G.S. even had a word to say about that.

Q. Would you tell us what it is you are looking at?

A. I'm looking here at Terence Danielson et. al, 1981, USGS open file report 81-539.

Q. Is that a document Mr. Montgomery used to form his opinions?

A. I believe so. Care should be taken in selecting springs for monitoring. The discharge recession curves of springs that are supported by more than one water-bearing zone may not be similar from year to year because of nonconformity of recharge to the different zones from year to year. Also, algae and plant roots could clog the plumbing in developed springs, resulting in an unnatural change in flow characteristics. Ideally, the monitoring of spring discharges should be in conjunction with water-level monitoring in observation wells, in order to detect recharge that may occur during the normal recession period that would alter the recession curve."

Q. What does that mean to us layman?

A. Don't take Bear Spring to represent hydrologic systems in a region.

Q. Why not?

A. Because it is very different from the others. It might have young water, you might have a rainfall today, spring will increase next week, double or triple. Whereas at Birch, tritium data suggests that Birch is very old water, similar to the water that's encountered in the mine, it's old, old water, it's been stored there for years, thousands of years.

If its recharge area is far away and it's very old water, it might be three years of sustained high precipitation to get a deflection in the flow. So, to say that the one little spring is representative of the area, is just not accurate. We can show that with all those curves.

Q. Let's talk a little bit about water, both groundwater and water infiltrating from this surface to the Tank Seam. You've stated that you examined that area and generally are familiar with the area?

A. With Bear Canyon?

Q. Yes.

A. Yes.

Q. Are there fault lines, fractures above the Tank Seam?

A. Not that I'm aware of.

Q. If there are, are you aware of any water that comes out of the mountain in the form of springs or otherwise above the Tank Seam?

A. I believe there are some springs above the Tank Seam, I haven't visited those myself.

Q. Well, what's the source of that information?

A. Charles Reynolds.

MR. LAURISKI: I'm sorry?

A. Charles Reynolds.

Q. If in fact there are springs, water coming out, from faults above the Tank Seam, what would be the source of that water?

A. Faults above the Tank Seam.

Q. Above the Tank Seam?

A. I'm not -- I don't think there are faults above the Tank Seam.

Q. Okay.

A. There are springs that issue from the mountain side.

Q. Above the Tank Seam?

A. Un-huh.

Q. What would be the source of that water?

A. That water would be infiltrating through the ridge, coming down hitting the permeable layer like a shale and going out to the edge of the canyon.

Q. Obviously if the water is doing that it never makes it to the Birch Spring or Big Bear Spring?

A. Right. There are some impermeable zones from the top down heading out that way, so it's not going to recharge the springs. Recharge over the mine permit area is going to be very insignificant.

Q. Are you aware of any other difficulties with the exhibits that were offered in connection with Mr. Montgomery's testimony or his testimony itself?

A. Just generally that they are very general. They're region wide, not specifically the site. We have specific data that suggested a different story. Some of the things were far too general, and in fact I think misleading. They may be true for the region, but not true for the site.

Q. Are we able to draw any conclusions through precipitation information we have as to the impact on Birch Springs and Big Bear Spring of mining the Tank Seam?

A. I don't believe there will be any impact at all. I don't believe there's an impact mining Blind Canyon Seam, and they're absolutely would be no impact mining the tank which is 200 feet above.

Q. I believe I have no further questions at this time.

MR. MITCHELL: I have a couple of questions.

MR. LAURISKI: Mr. Mitchell, before you go, Mr. Murray, I believe, had a question.

MR. MURRAY: I have one question. On the Birch, is there any culinary industrial development there that's causing that in that recharge on Birch Spring that you know of?

THE WITNESS: Not that I'm aware of.

MR. MURRAY: Okay.

MR. LAURISKI: Mr. Mitchell?

BY MR. MITCHELL:

Q. Mr. Garr, for illustrative purposes you have shown a ridge line with the Tank Seam and Blind Canyon Seam showing the water bearing formations that you encountered with the wells you drilled, monitoring wells you drilled.

Can you provide an overview picture of what we're looking at in terms of what the recharge area is? In other words, are we talking about a large plateau overlying the Tank Seam in this area or are we talking a high thin ridge?

A. You follow this ridge up. We get to the top of the north Horn Formation, this is highly fractured through here. I don't know anything more about this than it's the shattered zone. We don't know what it's like in depth. This is a broad area, both east/west and north/south, flat. Water's going to percolate down through here, probably through fractures, possibly through some faults, we don't know. But it's a much more likely recharge area for these aquifers. The Star Point.

Q. What formation?

A. Star Point formation.

Q. The fracture zone?

A. This is just the shattered zone, in the north Horn.

Q. Is that part of the Flagstaff limestone?

A. North Horn, they are not synonymous, but integrate into each other.

Q. You earlier expressed some familiarity with the Monograph, USGS Monograph relied upon by Mr. Montgomery, Danielson, et. al, 1981 survey. Are you familiar with those authors' conclusion that recharge to the Star Point/Blackhawk aquifer, direct infiltration of snow melt in areas of outcrop, probably is small in comparison to direct recharge to the Flagstaff Limestone?

A. I've read that before.

Q. Does that fit with your theory?

A. Yes.

Q. Of how this works?

A. Yes.

Q. What does -- what did those authors state concerning recharge? How does that fit with Mr. Montgomery's theory of effect on recharge concerning mining of the Tank and Blind Canyon at these locations?

A. It's difficult to explain other than very broad flat areas that are fractured are going to be much better, more efficient at getting the precipitation in to the groundwater system. This is the ridge out here, like this.

Q. Is it safe to say that sieves shaped like a bowl allow water through them better than knives up on edge?

A. Yes, sir.

Q. Would that be a good example of why one theory makes more sense than the other?

A. Yes.

Q. And it's also based on what the USGS has said?

A. Absolutely. There is going to be some small amount of infiltration through here, but it certainly is not supplying anything meaningful. You have this recharge area up here, tens of thousands of more times surface area, more permeable. Not going to have the runoff that this does. Recharge here is really insignificant compared to this up here. In fact what we see, this is being recharged at the higher elevation.

Q. Are you familiar with the statement in Danielson where the authors state, I believe it's page 38, "Subsidence has not been extensive and where water-bearing zones that overlie the Star Point-Blackhawk aquifer are perched, it is unlikely that mine dewatering induces greater recharge to the groundwater system. Neither is it likely under these conditions that the flow of springs that issue from the perched zones or the rate of natural downward leakage into the Star Point-Blackhawk aquifer are affected by mine dewatering."

A. That's what we've been saying all along, that the water that the mine encounters when they drill the bolt hole, or if they drill into the Tank and get a dripper, we think of hitting this perched ledge, and they're not rerouting the water that would be destined to the springs.

Q. Is it fair to say the USGS monograph for this area actually supports your theory of what's going on here better than it does a theory of one integrated cohesive regional aquifer?

A. There are probably a lot more in there that would confirm what we are saying. I have not read that document in its entirety.

Q. Thank you. I have nothing further.

MR. SMITH: I have a few questions. If I can approach the Board here, maybe that will help me ask the questions.

MR. LAURISKI: If you'll keep your voice up.

MR. SMITH: I rarely have a problem with that. In the Supreme Court in New Mexico I was told to lower my voice. So I will do my best to keep it up. I don't have a problem.

Q. As I understand it, Mr. Garr, this is Gentry Mountain up here, right? And it's a big flat top mountain. When I was younger I hunted a few deer up there. It's a flat top mountain, isn't that correct?

A. Yes.

Q. And exposed to Gentry Mountain it's not the Star Point Sandstone or the Blackhawk Formation, those aren't exposed up here? They're not exposed, it's the North Horn, is that what you said?

A. Yes.

Q. That's correct?

A. Yes. My cross-section shows the North Horn.

Q. That's exposed up here and it has to work through, the water has to work through a number of layers of rock. In fact, on my chart which is Exhibit 7, we haven't had this admitted in to evidence, but Exhibit 7, is it has to work through Price River formation, another formation, the Castlegate sandstone, before reaches the upper part of the Blackhawk Formation and the coal is in the lower part of the Blackhawk, is that correct?

A. Absolutely.

Q. And so we have got these rocks, Star Point Sandstone's back here, and then back here is also the Blackhawk Formation. Now, my understanding is that the water moves not only down, but it's moving to the south in that area; is that correct?

A. Yes.

Q. So if the water would move along an aquifer or along a rock, it would move south towards what we have Big Bear and Birch Springs, they're kind of at the end of this, right?

A. Yes.

Q. And all this, my understanding from your report, is that Birch Springs and Big Bear Spring are also recharged up in this area; is that correct?

A. We think that's more likely.

Q. Okay. Isn't it also likely that as water moves down these, aren't -- you put straight lines here, but that's not how water moves, it doesn't move in straight lines down and over, right? It moves into one rock and up along the formation until it finds another fault?

A. It's going to fall into fractures.

Q. Kind of a stepped approach?

A. I don't know if they are stepped, maybe vertical.

Q. But the water -- and in fact, from your tritium data, the Birch Springs water was the same age as the water you're encountering in the mine; isn't that correct?

A. It was analyzed as pre bomb water.

Q. Very close in tritium, am I correct?

A. Yes.

Q. So --

A. It was old water.

Q. Isn't it kind of funny to say that here they're all being recharged, and water -- or maybe I should phrase it this way. Some of the water recharging here maybe is in the mine here, and then would later move down in to the Birch Spring, but it's being intercepted and taken out of the mine. Isn't that a plausible scenario?

A. How is it going to move through the Mancos shales?

Q. It's moving somewhere because the Mancos shales are back in here too. If they were separating this -- excuse me, let me --

MR. HANSEN: Objection, no evidence to suggest there are --

MR. SMITH: All of the evidence is that the Mancos shale tongues, you're saying, separate the Birch Spring and the Big Bear Spring from this other aquifer, isn't that correct? But if the Mancos shale was in here it would separate it here. There would be no water for those springs, if you had this barrier you're talking about here. That's so impermeable here.

MR. MITCHELL: Let him answer the question.

THE WITNESS: You are doing very well.

Q. Thank you.

A. I'm saying, I don't know what the business is about the Birch and Big Bear being separated, I've got three separate aquifers here separated by two shales.

Q. But aren't they somewhere, at some point, the water is going through that shale. How could it get there? No doubt it is, right?

A. Fractures.

Q. Fractures.

A. I'm not going to fracture my sandstone and not my shales.

Q. So there's fractures and that's how the water moves from the North Horn high level down, way down here to the Star Point Sandstone; isn't that correct?

A. Yes.

Q. Gees, if there's fractures over here, why aren't there fractures here, or are there fractures there?

A. This is a zone of intense fracture. I don't know how it goes there, but USGS has identified it as such. That's good enough for me.

Q. That's good enough for you, what USGS says. USGS also says that the Star Point Sandstone and the Blackhawk Formation are one regional aquifer; is that good enough for you?

A. In a general sense, no. Not at this site because I have data to suggest otherwise.

Q. You believe them over here, but you don't believe them over here?

A. When a geologist goes in and maps the shattered zone, I'll believe it. I'd like to go see it. I'd like to kick around in it. I haven't done that. But I'm going to believe that if he delineates that on a map as a shattered zone. I'll believe that. If I look at regional wide, Wasatch Plateau wide report that shows one water table shooting through there, I'll say that's great for now, let's get site specific data, which we have done.

Q. Any site specific data here? You're just relying on what the USGS says here, right?

A. Yes. It doesn't enter into this question, where does the recharge come from. That's a real good place for it here. Beats the heck out of that ridge.

Q. Isn't it likely there's some fractures, faults that move the water from here to Birch Springs there? It's the same age water, right?

A. It's possible. But how are you going to get the groundwater in the mine below the mine to Birch Springs? You've got that fault I was talking about, Blind Canyon. Then you've got to go 800 feet further. And we've got information on how slow water does move through the sandstone, if you'd like to hear that.

Q. I just want answers to my questions. But the water is moving from a much higher level here for recharge. It's getting down here somehow, it's not coming out of nowhere, out of Birch Springs; isn't that right?

A. Moving much farther than you're saying.

MR. MITCHELL: I think the question has been asked and answered. He asked him and he told him. I don't see any point beating him over the head with it any more.

MR. LAURISKI: I agree, I think the question is asked and answered.

BY MR. SMITH:

Q. Some of the water -- now, there is water?

MR. MITCHELL: I think that's been ruled on.

MR. LAURISKI: Again, you guys are up there arguing with each other and we're missing all the testimony. If you would slow down and the reporter could that, it would be appreciated. Thank you.

BY MR. SMITH:

Q. There is water in the Blackhawk Formation, right?

A. Yes.

Q. That water recharges up here?

A. I'm not sure about that.

Q. You're not sure?

A. I don't have data.

Q. You don't know where the groundwater comes from?

A. I know there's perched water in the Blackhawk that may come from here.

Q. I see. I'm sorry, I misunderstood you. I thought you said Gentry Mountain was the regional recharge for these aquifers; is that correct?

MR. MITCHELL: Mischaracterized his testimony. He agreed with the USGS report which says the primary source of recharge for the Star Point Sandstone was the Horn Formation to the north. I don't see any reason in trying to get more out of him than what he agreed.

THE WITNESS: It contributes to the recharge.

Q. Tell me what's recharging the Blackhawk Formation there?

A. I don't know. I don't know if you can say there was recharge. There's precipitation coming down on the ridge, a small amount of water comes down and gets perched. If you take a bolt hole and go up, at that point you'll drain that with a little dripper.

Q. Would you call 500 gallons a minute a very minimal amount of water?

A. I don't think that's what's happened.

Q. It's in your report.

A. I don't believe it's all perched water.

Q. Where is it coming from?

A. Possibly out of the floor.

Q. So where's the floor water coming from?

A. Here.

Q. Out of the Star Point?

A. Correct. We don't know how much.

Q. And you're here today to tell me there's no interconnection between these two aquifers?

A. Which two?

Q. The Star Point, which the springs issue from, and the Blackhawk?

A. I don't think I said that.

Q. I'm sorry. So the aquifers are interconnected; is that what you are saying?

A. I don't think I'd say that.

Q. Well, tell me what you're gonna say?

A. I think there are some more holes at the north end of the mine that intercept on the Star Point aquifers and the pressure is coming up. I don't know how much.

Q. Can you point that to me?

A. If you penetrate that at this northern end, you're gonna get water coming up out of there.

Q. Can you point to me, in the PHC you prepared, or the Exhibit D, that hydraulic analysis, you mentioned that even --

A. There's phrasing there, "undetermined amount of water from the floor", I believe.

Q. But the major water that comes into the mine is from the roof, isn't that correct?
A. That's what is being said, I'm not sure.
Q. I don't want to misquote you, you helped prepare this PHC didn't you?
A. Yes, I did.
Q. And it says here on page 2-13, groundwater enters the Blind Canyon Seam of the Bear Canyon mine through fractures and roof bolt holes?
A. Yes.
Q. It doesn't mention anything about the floor water that you are bringing up now.
A. It's in there somewhere.
Q. Please point me to it.
A. If that's the mine to the north and as they -- the floor advances with them and rises up.
Q. Let me see.
A. We inferred it's perched, but we don't know.
Q. I see. So you don't think the Blackhawk Formation is getting recharged on Gentry like the Birch Springs?
A. I think it's getting a very small amount.
Q. Why isn't it getting --
A. We have tritium analysis of these drippers to suggest it's all pre bomb, old water which fits with the

perched idea.

Q. So does Birch Springs have the same tritium analysis?

A. Relatively, pre bomb water.

Q. That would be the same water based on that analysis, same source?

MR. MITCHELL: That's argumentative, he's been asked and he answered that.

THE WITNESS: Not necessarily.

BY MR. SMITH:

Q. Can't distinguish it by tritium analysis?

A. All you can see is it's relatively old or new.

Q. And both waters, both Birch Springs and the mine water are relatively old based on tritium analysis; is that correct?

A. Un-huh.

Q. You need to say yes or no so our reporter can get it.

A. I said yes.

Q. Thank you. Let me move you to this chart a little bit. I think it's Exhibit 16. Following up on a question from the Board, you don't have any explanation for the dramatic decline in Birch Springs, do you?

A. I don't.

Q. Don't you think that should be a matter of concern since it's so close in that area?

MR. MITCHELL: Concern to him, concern to who?

THE WITNESS: My client hasn't requested I investigate that.

BY MR. SMITH:

Q. I see. In preparing your PHC, on page 2-10, you didn't even take any initial measurements of either Big Bear Spring or Birch Spring in preparing the possible hydrologic consequences, did you?

A. No, we did not.

Q. So?

A. We haven't taken any measurements.

Q. You haven't taken measurements, yet you're here giving expert opinion, expert opinion under oath? I think we put you under oath.

A. Yes, you did.

Q. That there's no effects from the mining activities on these springs, yet you didn't bother to take initial measurements of these springs?

A. I don't take the measurements, EarthFax Engineering didn't, the mine did.

Q. Okay. Wouldn't you say that's a significant flaw in the PHC?

A. No.

Q. It's not?

A. No. The water company didn't bother to take any measurements prior to 1989 at Birch Springs.

Q. They're not here trying to get a permit approved, you are. So what they did is completely irrelevant, what's recommended?

A. We rely --

MR. MITCHELL: Let's not argue with the witness. Ask him a question let him answer it and then ask the next question.

THE WITNESS: We don't have -- we have taken them at face value and used their flow numbers to generate our graphs.

BY MR. SMITH:

Q. You don't consider that to be a flaw?

A. No.

MR. MITCHELL: He's answered that no.

MR. SMITH: I asked him if it was a major flaw.

MR. LAURISKI: Well, I'll tell you, we're losing our patience with all the arguing that's going on in the room. Ask questions and please answer the question and let's move forward. Perhaps when we get through with this witness it would be a good time to take a break so you guys can relax a little bit, okay?

MR. SMITH: I have a few more questions. I apologize and appreciate the patience of the Board.

MR. LAURISKI: The Board has an interest in getting to the facts and determining whether or not the petition is valid. And that's what we're here to determine. We're not here to referee arguments between witnesses and counsel. So let's try to keep focused on the issues so we can all move forward on this matter.

BY MR. SMITH:

Q. Let me direct your attention to 2-6 of the PHC. The last sentence starting on that page, it says, "The Star Point Sandstone together with the lower Blackhawk Formation are considered by Lines to be a regional aquifer." You see that statement?

A. Yes.

Q. That was Mr. Lines' best opinion; isn't that correct?

A. I can only assume.

Q. But, and you testified before you don't agree with that?

MR. MITCHELL: No, that's mischaracterizing his testimony.

THE WITNESS: That's not what I testified.

MR. LAURISKI: Mr. Mitchell, let -- if he disagrees that's what he said, let him answer, okay? Thank you.

THE WITNESS: As I said before, Mr. Lines' work, I hold in high regard. But it is regional, and I think that Mr. Lines, being the good geologist he is, would have to modify the case for this site, based on the information we have, based on region wide information.

Very generally, he is dead on. It's a wonderful study, but it's not gonna be like that across the entire Wasatch Plateau, that's not real. Mr. Montgomery knows that, I know that, Mr. Lines would know that.

BY MR. SMITH:

Q. Let's go to page 2-8.

MR. LAURISKI: I'm sorry, two?

BY MR. SMITH:

Q. 2-8. It says, "Outcrops within the permit area include the Price River Formation -- this is the last paragraph -- Castlegate Sandstone, Blackhawk Formation, Star Point Sandstone and the Mancos Shale." Is that correct?

A. Yes.

Q. You are referring to?

A. Yes.

Q. "Indicate that recharge to the Star Point-Blackhawk aquifer from direct infiltration of snowmelt to formations which outcrop below the North Horn Formation is small in comparison to recharge through low relief surfaces on the North Horn Formation."

That's the top of Gentry Mountain; is that correct?

A. Yes.

Q. "In the study area, exposures of formations below the North Horn Formation and above the coal outcrops are limited to steep canyons. Therefore, the potential for recharge through these formations to the regional groundwater system within the permit area is limited."; is that correct?

A. Yes.

Q. And so, as I understand it, the area -- we have been through this and I'll quickly move to recharge -- is up on Gentry Mountain, not regional aquifer then?

A. I wouldn't say that.

Q. Okay.

A. For the regional aquifer there's recharge all over the place. But in this area, in the area of Co-op, recharge is much more likely to occur on Gentry as the USGS says, on flat areas with a lot of surface area open to the sky. It's not gonna occur very efficiently on steep slopes over the mine.

Q. And that, in both the Blackhawk and Sandstone underlie this recharge area; is that correct?

A. Yes.

Q. Okay. A little farther down on the same page on 2-9 it says, "No springs were found within the permit area." Is that correct? See where I'm reading from?

A. Yes, "within the present permit area".

Q. So Birch Springs and Big Bear Spring are outside the permit area?

A. I believe so.

Q. Okay.

MS. LEVER: What about the line in between?

MR. SMITH: I'm sorry?

MS. LEVER: You skipped a sentence.

MR. SMITH: Okay. We can read that too. "Within the proposed expansion area there are three springs associated with the perched aquifers above the coals mined by Co-op Mining Company". Is that the line?

MS. LEVER: Are they the same springs we are talking about?

MR. SMITH: I'm not sure. Don't ask me, I'm the wrong person.

MS. LEVER: I'm sorry. Do you want to ask Mr. Garr?

THE WITNESS: Are you referring to a number of low volume springs, two GPM or less?

MS. LEVER: Just go on.

BY MR. SMITH:

Q. The two largest springs, Big Bear -- I'm skipping down. I want to try to focus on some important, what I consider to be important facts in here. About two thirds of the way down that paragraph starts out a sentence saying "The two largest springs in the area, Big Bear." Are you following me?

A. Yes.

Q. "Big Bear Springs and Birch Springs are associated with fault and joint zones and issue from the Panther Tongue of the Star Point Sandstone".

A. Yes.

Q. So those springs issue from fractures or faults; isn't that correct?

A. Fractures.

Q. Do you know how far up he fracture goes that Birch Springs issues from?

A. No.

Q. For all you know it could go all the way up to the Blackhawk Formation or farther up?

A. It may.

Q. And water could be coming through that?

A. Yes.

Q. You just don't know?

A. I think it probably is.

Q. I see.

A. It's a joint system.

Q. And the same thing with Birch Springs and Big

Bear both, they're issuing from faults that are going upward from the springs?

A. Issuing from joints.

Q. Can you explain just -- I'm a layman -- what's the difference between a joint and a fault?

A. A joint simply is a crack, there's been no relative movement across that. A fault, by definition, has relative movement.

Q. If I can show you Exhibit 3, is this the -- would this be the joint we are talking about in Exhibit 3, where the rock -- it appears to be rock going a different direction in the upper left hand corner of Exhibit 3?

A. It looks like that to me. I haven't studied that area, as I said.

Q. I see. Okay. And you're not sure how far that joint goes up into a higher strata?

A. No. I know it's 800 feet from the Blind Canyon fault however, and both north trending.

Q. Go to page 2-13. This is a section we've been through before, actually we've been through these sections before, but I want to ask a couple of questions. The first full paragraph that says, "Groundwater enters the Blind Canyon Seam of the Bear Canyon Mine through roof bolt holes."

Where would that water, without mining water that's moving through a fracture, where would it naturally go if you weren't mining in the area and intercepting the water through the mining process?

A. Generally until it hits an impermeable layer , and if that were not fractured it would follow that until it hit the daylight.

Q. And that's where the water -- that's why we have Birch Springs and Big Bear Springs where they are because water is working both downward and southward?

A. Yes.

Q. From this recharged area in Gentry until it hits an impermeable area?

A. Probably further north.

Q. Even further?

A. That's not the exclusive recharge, we should stop saying that.

Q. That recharge and other recharge areas, water will move both southward and straight down or downward, until it reaches that impermeable layer and comes out as a spring; is that correct?

A. Yes.

Q. And both the Blackhawk and the coal seams and the Blackhawk Formation that are being mined by Co-op supposedly, are both up gradient and north of these two springs; is that correct?

A. They are higher. I'm not sure where they are proposing to mine in their lease relative to the current workings.

Q. And they also are north, is that correct, they could be south?

A. I don't know where they're proposing to mine the Tank Seam.

Q. I see. The Birch Springs, at the very edge where that hole -- maybe I could draw that and save a little time. We have Trail Canyon here and we have Big Bear here, and Birch is right there and Big Bear is right there. There isn't much where they could mine south, therefore, because this is Huntington Canyon, Birch Springs is right there. So where they are mining is north, obviously, of these two springs?

A. Yes.

Q. Okay. Now, on 2-13, that last paragraph, the previous witness -- you were here when Mr. Reynolds testified and said there were mistakes in that paragraph. Were you aware before of his mistakes in that paragraph?

A. It was two or three weeks ago, he called and asked said that the DOGM wanted a revision of the PHC and would I please put the corrected values in red line strike out so they could submit on page 2-14.

Q. Do you know who gathered the information that was put in here about the counting of 500 gallons per minute?

A. I understood it was Mr. Reynolds.

Q. Anybody from Earthfax go down and verify the numbers?

A. No.

Q. You just took Mr. Reynolds' information, and incorporated in the PHC?

A. It's referenced that way.

Q. Okay.

A. It's not our job to judge whether our client's being honest with us or not.

Q. I'm not saying it is. Go to 2-22. That's a Piper Diagram, isn't it? What I understand is a Piper Diagram, and I'm no geologist, but that is where you take the mineral contents of water, and then diagram it out to compare how similar waters are; is that correct?

A. That's my understanding. I'm not a geochemist, and I didn't produce this, but that's my understanding.

Q. Who did produce these?

A. Earthfax employee, water data.

Q. Is he here? If he's going to testify I'll save the questions.

A. She is not here.

Q. I'm sorry. Okay. And from this diagram, the water of Birch Springs seems to be a little bit -- that's number one on that diagram?

A. Yes.

Q. The point by the 1 seems to be close, but a little separated from the rest of the points of water. These are some of -- this water is the spring and some is water found in the mine, but the water from Birch Springs is very close, in fact it fits right in with the other water?

MR. MITCHELL: I think it's established he's not qualified.

THE WITNESS: I can't say anything about this, to be honest.

BY MR. SMITH:

Q. Okay.

A. I can't interpret these diagrams.

Q. You can't. Okay. Go to page 2-33 and you have six reasons why, at least the report has six reasons why you don't believe there's a connection between Birch Springs and Big Bear Springs and the water in the mine, encountered in the mine?

A. Yes.

Q. Number 1 is a Tritium test. Isn't that correct? But the Tritium test does not disqualify Birch Springs?

A. No, and it doesn't say anything about that.

Q. Okay. I just want to make sure that's clear. The next one is the Stiff Piper Diagram. They don't disqualify the Big Bear Springs in any way; is that correct?

A. We had Tritium data suggesting Big Bear was different water from the mine, also from Birch. We had chemical data suggesting Birch was different.

Q. Isn't the converse true as well, that the Tritium data suggested that the Birch Spring was the same as the mine, and the chemical data suggested that the Big Bear Spring is the same as the mine? Doesn't it work both ways?

A. No.

Q. Why not?

A. It doesn't. All the Tritium data -- it's talking about the age, not the source. It's not talking about the source or the chemistry outside of hydrogen ions. It's talking about the relative age. This water was in the atmosphere prior to open air bombing in the '50s, that's all it's saying.

Q. Based on that data, you would say they're probably the same water?

A. Again I will say, based on that data I will say they are similar age, relative age, not source.

Q. But --

A. They are old water.

Q. But you're using these tests to determine what the sources are of this water, isn't that correct?

A. Generally, yes. If we find young water coming out of Big Bear Spring for instance, relatively young water, then we can say -- we can't say there's no connection. But we can infer this is getting recharged from a different location than just the mine because the mine is old water. If Big Bear Spring were being recharged from the Panther mine, it would be very low in Tritium counts. Also, it would be old water. We're using as many tools as we can to characterize this stuff. You're gonna have a water of a certain chemistry that you get here in Salt Lake, and then go to Saudia Arabia and find the identical composition in the water. That's not the same source, is it? That's what we're talking about here.

Q. Just one more area I want to talk about, one more question really. On page 2-28, it says, "Waters from DH-1A", I guess that was a drill hole in the mine, I take it?

A. Second line.

Q. Second line?

A. Yes.

Q. "And DH-3 have Stiff patterns similar to those of the calcium-bicarbonate spring water depicted on Figure 2-2. Water from DH-2 has a calcium, magnesium, sodium, potassium-sulfate pattern. This pattern is distinctly different from other groundwater that has been sampled in the permit and adjacent areas, and is presumed to be due to the dissolution of locally-occurring sulfate salts."

A. Gypsum.

Q. There's some different mineralization of water found within the drill holes of the mine; is that correct?

A. Yes.

Q. Yet you're using chemical analysis to distinguish the spring water from the mine water. Couldn't the difference in the spring water be from some locally-occurring, as you put it, locally-occurring sulfate salts near the mouth of the spring?

A. Yes.

Q. So --

A. You see what we're working with here?

Q. Yes. So not an exact science, is it?

A. No, it is not. That's why we have to use as many tools as we can and do as much work as we can and gather as much data as we can to come up with a story.

MR. SMITH: That's all I have, thank you, Mr. Garr.

(Whereupon a recess was taken.)

MR. LAURISKI: We'll be back on the record. Mr. Appel, I believe you have cross-examination of Mr. Garr.

MR. APPEL: That's correct. I should remain standing, Mr. Garr.

MR. LAURISKI: Before you do, go off the record.

(Whereupon a discussion was held off the record.)

MR. LAURISKI: With that, we'll go on the record. Mr. Appel, you may proceed.

BY MR. APPEL:

Q. Mr. Garr, with respect to this particular drawing which you have on the Board, did I understand you to say that your view of movement of this water is it comes in the shattered zone, enters Star Point that way, and then moves down in this particular direction, because they're basically some confining members within the Star Point?

A. I think that it's probably saturated up here also. I think it's saturated to the north. This probably contributes to it. Nobody really knows for sure. All I'm saying is this is a lot better recharge area close to the mine than this. Very simply that.

Q. This is a little awkward. Could you go around this exhibit. What does this line mean right here?

A. This is the potentiometric surface right here. Right here is the mine floor. These are logs just very general logs from the mine floor to the total depth of the wells. We checked the water level and hydrologic characteristics of the aquifers, in each of these aquifers in each of these holes. We isolated it with the packer (sic) system, tested just that aquifer, drilled on, tested just that aquifer, isolated this aquifer from the one above it. This is the groundwater surface.

Q. This line would reflect the down gradient movement of subsurface water?

A. This line shows where spring canyon water is. This is the spring canyon aquifer under pressure, confined, and it pushes up to this elevation above the mine floor, if you are just below the mine floor.

Q. So, they're not really confining geologic members, they actually have some communication of water in between them?

A. I'm not saying this water is up in here, no. This is the potential surface, that's the pressure, expression of the pressure that the water in this aquifer is under.

Q. Where did you encounter water?

A. In that aquifer, as soon as we hit it.

Q. Where did you encounter water in this aquifer?

A. We didn't.

Q. Absolutely none at all?

A. I don't recall any.

Q. Okay. Now, this is the mine floor, correct?

A. Yes.

Q. So, it's safe to say that very shortly this particular surface that you've identified here, is going to interact with the mine floor within how many feet?

A. I'm not sure where it's going to hit.

Q. If the mine --

A. You have progressions. You picked it.

Q. Right. There's a reason for that. If the mine were not there, then this line would intersect the mine floor approximately what, six feet from where you have it?

A. If you had a conduit, which is what we created when we drilled down there, we provided it a means of getting up to that height.

Q. But in fact, there are joints and fractures throughout all these structures. You testified to that. And it would start at the bottom of the Mancos

Shale and the same fractures would be pervasive to this entire section particularly?

A. I'm not sure of that, I'm not sure they would connect up. I don't know, through going through fractures.

Q. Didn't you testify that if the sandstone was fracturing that your shales were going to fracture as well?

A. No, a joint area such as Birch, yes, there's lenses fractured, discontinuous fracturing here.

Q. In fact, refracturing?

A. This water is coming up in the mine floor through fractures.

Q. Thus they can also go down, if the water level was below, down here?

A. Yes.

Q. So, it will move down, down gradient this way as well as across gradient this way?

A. Primarily, the floor horizontally.

Q. Okay.

MR. LAURISKI: Can I ask a clarifying question here? When you reference the mine floor, Mr. Garr, are you talking about the Blind Canyon Seam mine?

THE WITNESS: Yes.

MR. LAURISKI: Or the Tank Seam?

THE WITNESS: Blind Canyon. We started the wells from the floor of the Blind Canyon.

BY MR. APPEL:

Q. Let's go over to your drawing here. Now, we just discussed the fact there are fractures and joints through this area, and you admit they exist?

A. Not necessarily. I don't know.

Q. How did joints and fractures, how are they created?

A. Through extension, you can break them by extending, have the same kind of thing going upward. Subsidence can do it.

Q. It's a response to stress created within the earth's crust?

A. Yes.

Q. Okay. Chances of it being different from one section to another are fairly slim, aren't they?

A. I'm not sure I understand what you are saying.

Q. Usually you have an area that is usually -- you have an area that has similarities with its jointing and fracturing; isn't that correct?

A. Yes.

Q. Because it's really responding to regional stress?

A. Usually, yes.

Q. Now, you testified before that one of the reasons you disagreed with Mr. Montgomery's position is that you feel that the water -- tell me if I'm wrong. I'll ask you what I know his theory is. His theory is the regional water table, we have called it regional aquifer, that doesn't help me as much as the water table because as you know, we're moving between layers. It's difficult, but comes approximately like --

A. That is a permanent marker by the way.

Q. Oh.

A. I discovered that.

Q. Let's just -- approximately like this.

MR. HANSEN: Objection, there's been no testimony.

THE WITNESS: I don't think he said that.

BY MR. APPEL:

Q. Why don't you show me where the extreme --

A. I don't think it's that extreme of depth.

Q. Help me where you think --

A. I'd like to see where he put it. I don't know where he'd put it. He put it -- he takes the USGS information, the regional general block diagrams, and runs a single water table crossing the Blackhawk and the Star Point. We've got three different aquifers with three different heads. That suggests that those confining layers are competent, and it doesn't suggest a lot of vertical communication from water in an outward tongue to a lower tongue. It suggests the opposite, that the shale units are competent to sustain the pressure.

Q. Competent enough to transport the water along those particular bedding plans you've suggested within the Star Point?

A. Yes.

Q. That's your conclusion?

A. Yes.

Q. And your conclusion is they're below the Blind Canyon Seam?

A. Currently, yes.

Q. Now. If these levels of layers are so competent, and there's no communication between them, why don't we have springs like Bear Canyon and Birch Spring coming out where they exit in the side of the wall rather than everything coming out in Birch and Bear where it hits the Mancos shale?

A. There's water flow through those aquifers to the surface. It moves very very slowly when it gets to the surface. You can see at those outcrops it is damp. Not through the full thickness necessarily, because we have even shown they are not fully saturated at the south end. You see more effervescence or salt deposits on the cliff face, suggesting minerals carried along by the groundwater when they pit the interface with the atmosphere.

It's not correct to say there's an absence of water at the outcrop. There's an absence of measurable water, and the springs are in joints for a reason, because joints are conduits.

Q. You didn't have that same absence of measurable water for drill holes, did you?

A. There was measurable water, of course those units are saturated, yes. The water is moving very slowly.

Q. When they come out here they are not saturated. Where is this water going?

A. It's going out at the outcrop.

Q. Down at these springs -- is it equally possible it's exiting from the spring?

A. Not from the aquifers below the mine. I don't think that's the case. It's exiting at the outcrop. If it were all going to springs, you wouldn't see effervescent outcrops on the south of the mountain. You wouldn't see dampness.

Q. Let's walk through this again. You have joints and fractures throughout this area. Are you willing to concede that?

A. I don't know to what extent I have seen fractures in the ceiling. The rock is fractured. I don't know how much water has communicated.

Q. And this water moves through joints and fractures in this particular area?

A. Yes.

Q. So isn't it also equally possible, rather than slowly seeping out in quantities we can't really see, that this water is in fact moving along through here, down joints and fractures through three layers, and exiting once it hits the Mancos shale which is a far more plastic substance than these other more brittle shales and sandstones?

MR. MITCHELL: I want to object. That question has been asked to him twice now, and each time he has answered it and he said because of the competence of the shale, between those, he believes it is highly unlikely. If he's asked this until eight or 9:00 tonight, I think he's a tough guy, and I think he'll hang in there. But I don't see why we should have to live through it with him.

MR. MURRAY: I agree.

MR. APPEL: I think the question I asked is different. I've got him to admit there are joints and fractures. Mr. Mitchell doesn't like the fact --

MR. MITCHELL: He admitted that three questions ago, and he said, but I don't know if they are communicating joints and fractures through here because of the competence in the water pressure.

MR. LAURISKI: Mr. Garr, answer the question one more time, and we'll see where that takes us.

THE WITNESS: I need the question asked again. I'm not sure what it is.

MR. APPEL: I don't think you've heard this one before.

MR. LAURISKI: Ask the question.

BY MR. APPEL:

Q. There's a distinction between the -- let's call it the plastic nature of the Mancos shale and the shales within the Star Point. I'm asking you --

A. I don't know that there is.

Q. You don't know there isn't.

A. I didn't say there was.

Q. But the one thing we do know is that wherever water comes through here, exits at Birch and Big Bear when it hits the Mancos shale, correct?

A. I don't think that's really a thoroughly honest statement.

Q. Well --

A. It's my opinion, sir, that the water in Spring

Canyon, below the mine, exits at the face on the south end of the mountain, and that the water in the Storrs exits at the face of the south end of the mountain, and the water in the Panther exits there also. And that the water in Big Bear Spring and Birch Spring exits through joints when it hits the Mancos.

Q. Because of the nature of the Mancos, that's really the floor?

A. Because it's incredibly thick.

Q. So any water that does come --

A. That's the floor for Birch and Big Bear, yes.

Q. Okay.

A. It's not necessarily the floor, and I maintain it isn't for the aquifers below the mine.

Q. How thick is the Mancos shale?

A. Hundreds of feet, six or 700 in this area.

Q. Nearly a thousand. Okay. All right.

Let's -- that's your opinion. I also wonder, would you mine comparing the volume you have seen exiting the cliffs in the area?

A. I told you it's not measurable.

Q. Does that mean it's not very much?

A. It is very little.

Q. Very --

A. Because that water was -- moves very slowly.

Q. And using the same measuring stick, would it be correct to say that the water exiting Birch Springs and Big Bear Spring is very great?

A. There's a lot more water exiting there. It's concentrated into joints. It's a pipe, conduit collecting water, maybe for miles and miles up gradient flowing into the joints, going out through the face of the mountain.

Q. Back to this drawing. This particular -- is this hard for you to see at this point? How far is the lined area, this way to the north, from this particular hole? How many feet of the mine is there?

A. You'd have to ask Charles that, I'm not -- I can't recall.

Q. Would you be surprised if I told you it's over 2000 feet?

A. I think I'd be surprised if you told me it was 2000 feet.

Q. Would you be surprised if the permit area was 2000 feet beyond this drill hole?

A. No.

Q. If you have a drill hole 2000 feet this way, which on this scale would be quite a ways out, would you tell me where it would be?

A. On this scale, this is 400 feet and one inch, it would be here.

Q. From this drill hole?

A. Yes.

Q. Okay. As you back your potentiometric surfaces this way, when do you hit water out here if you drill a hole at the end of your mines?

A. I know we've got water in the north end, north mine, I believe it's called. There is water coming out of the floor. Stands to reason.

Q. And that's water --

A. Out of a well, out of a boring.

Q. In the floor?

A. Yes.

Q. And again, I have to ask the question, are we talking about in the Blind Canyon?

MR. LAURISKI: And again, I have to ask the question, are we talking about the Blind Canyon Seam or in the potential for the Tank Seam?

MR. MITCHELL: We're not anywhere near the Tank Seam.

MR. LAURISKI: That's why I'm more concerned.

MR. HANSEN: We're 200 feet below the Tank Seam.

MR. LAURISKI: We have sat here for, in essence, almost three hours, and I have yet to see how we've tied the Tank Seam -- the mining impact and the Tank Seam to the aquifers below the Blind Canyon Seam. It seems like everything we're driving at is dealing with the Blind Canyon Seam under the current mining permit.

MR. APPEL: I'm a question away from that.

MR. LAURISKI: Please get us to that question. Okay?

MR. APPEL: I know you've hated the direction I've approached this from all day, Mr. Chairman, but this is unfortunately easier for me.

Q. 200 feet above is here?

A. This is 800 feet vertical.

Q. I see.

A. 200 feet is up here so we project that out.

Q. When does your potentiometric surface hit?

A. I'm just going to take a wild stab and put it about here.

Q. What's your margin for error here? I know this is an unfair question for a geologist.

A. These are measured to a hundredth of a foot. I'm sure Charles' surveys are that good also.

Q. But water will migrate through these particular sections?

A. I'm not sure I understand what you mean.

Q. Because of --

A. This particular section?

Q. Between Spring Canyon Tongue and the Blackhawk Formation, up through the Mancos to Spring Canyon Tongue. In this general stratigraphy in this area, water will migrate because of the fractures up and down?

MR. MITCHELL: If there are fractures.

THE WITNESS: If there are fractures and this is under pressure with the change with the Mancos number one shale. Yes.

BY MR. APPEL:

Q. Okay. Thank you.

A. What's that got to do with the Tank Seam?

Q. I ask the questions.

A. I see.

MR. MITCHELL: You have any more questions?

MR. LAURISKI: Mr. Appel?

MR. APPEL: I've concluded.

MR. HANSEN: I have some very brief redirect. I may get some asked and answered objections, but I think there's a couple of points that were confused during cross-examination that should be made clear.

MR. LAURISKI: Well, I'm going to ask that counsel direct the questions to the impact of mining in the Tank Seam, how that's going to impact the water supply in the mine, the Tank Seam.

MR. HANSEN: I believe the question directly relates to that.

MR. LAURISKI: Okay.

BY MR. HANSEN:

Q. We have heard a lot of testimony about what may be going back up here in the Gentry area, in the North Horn formation, and basically what we know is we don't know very much about what's going on up here. But what can you tell me about what we do know about the water table, the aquifer here at the Tank Seam within the permit area?

A. Within the permit area, it's well below the Tank Seam, and in fact, much of the area is below the Blind Canyon Seam.

Q. The other question that I thought was unclear, I thought was confusing during cross-examination, I think can be addressed on this diagram. As I recall, this was a depiction of the location of Birch Canyon and Big Bear Springs. There is a major fault between those two springs, if you would show us approximately where that is?

A. This isn't to scale at all, and I'll probably put the spring somewhere out here. But it's 800 feet east and it's Blind Canyon fault.

Q. Now --

A. 800 feet. Mine workings are somewhere over -- this really ought to be out here also. Something like that.

Q. Does Co-op mine mine on this --

A. No.

Q. -- Birch Canyon side?

A. No.

Q. No mining that takes place on that side of the fault?

A. No, except 220 feet here.

Q. If you are -- if water intercepts on the mine side of this major fault, intercepts the fault, where does the fault direct that water towards?

A. The groundwater, the direction of movement of groundwater in these three separate aquifers is south, or southeast, a little different in each one. The fault here could act either as a conduit to flow, or as a barrier to flow, either way. If water for some reason decided to come from under the mine, hit this fault, it's either going to be stopped by a clay gouge filling the fault itself, be stopped, or it will be conducted through open voids. If it's conducted through open voids it's going to come out here and make a spring. There's no such spring here at Blind Canyon, to the Blind Canyon fault.

Over here, 800 feet away, we're asking the waters to somehow come from the mine, cross that fault somehow, and go 800 feet to affect Birch. It's just not very likely. There are so many other things that would happen to it before it did that. It's really not even a question.

There's no spring here. We can't get across 800 feet like that. This water moves so slowly, that anything in the mine, in the north main section they did up there, assuming it was going to travel horizontally and not hit faults, granted, not hit faults or fractures, it's going to take 200 some odd years to get to Birch Spring. Operating 10 or 12 years, we don't see the fracture system that this water could be entering. It just isn't there.

MR. HANSEN: No further questions.

MR. LAURISKI: Mr. Mitchell?

MR. MITCHELL: No questions.

MR. LAURISKI: Thank you, Mr. Garr. With that, we're going to go off the record now, and we'll continue at 1:00 p.m. on November the 17th. It will be in this Board room unless you hear differently. We'll reconvene on that date. Thank you all for your patience with us. Again, we'd just like to say we are interested in knowing the facts, and that's what we're here to do, and try to give a decision that's within the purview of the law. So with that, this hearing is closed for today.

(The hearing was adjourned to November 17, 1994.)

BEFORE THE BOARD OF OIL, GAS AND MINING

DEPARTMENT OF NATURAL RESOURCES

IN AND FOR THE STATE OF UTAH

IN THE MATTER OF THE REQUEST FOR AGENCY ACTION AND APPEAL OF DIVISION DETERMINATION TO APPROVE SIGNIFICANT REVISION TO PERMIT TO ALLOW MINING OF TANK SEAM BY CO-OP MINING COMPANY BY PETITIONERS NORTH EMERY WATER USERS ASSOCIATION, HUNTINGTON-CLEVELAND IRRIGATION COMPANY, AND CASTLE VALLEY SPECIAL SERVICES DISTRICT, CARBON COUNTY, UTAH.	DOCKET NO. 94-027 CAUSE NO. ACT/015/025 VOLUME II

THURSDAY, NOVEMBER 17, 1994, COMMENCING AT THE HOUR OF 1:00 P.M. A HEARING WAS HELD IN THE ABOVE MATTER BEFORE THE BOARD OF OIL, GAS, AND MINING, 355 WEST NORTH TEMPLE, 3 TRIAD CENTER, SUITE 520, SALT LAKE CITY, UTAH 84180-1203.

INTERMOUNTAIN COURT REPORTERS
5980 South Fashion Blvd.
Murray, Utah 84107
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FILE NO. 111794

REPORTED BY:
LINDA J. SMURTHWAITE, CSR, RPR, CM

ORIGINAL

APPEARANCES

CHAIRMAN: DAVE LAURISKI

BOARD MEMBERS: RAYMOND MURRAY
ELISE L. ERLER
JAY CHRISTENSEN
KENT STRINGHAM
JUDY LEVER
THOMAS FADDIES

STAFF MEMBERS:
JANICE L. BROWN, Secretary of the Board
JANEAN BURNS, Legal Secretary
THOMAS A. MITCHELL, Assistant Attorney General
JAMES W. CARTER, Director, Division of Oil, Gas and Mining
RONALD J. FIRTH, Associate Director of Oil and Gas, Division of Oil, Gas and Mining
LOWELL P. BRAXTON, Associate Director of Mining, Division of Oil, Gas and Mining
FRANK R. MATTHEWS, Petroleum Engineer
BRAD G. HILL, Geologist
RON DANIELS, Coordinator of Minerals Research

FOR PETITIONERS:
HUNTINGTON/CLEVELAND: CRAIG SMITH, ESQ.
CASTEL VALLEY: JEFF APPEL, ESQ.

FOR CO-OP MINE: MARK HANSEN, ESQ.

FOR THE DIVISION: THOMAS MITCHELL, ESQ.

I N D E X

Q. Do you recall how much?

A. It was for the month of October, the total discharge was, if I recall, it was around 140 gallons a minute that was discharged into Bear Creek.

Q. And is water still being used inside the mine for mining purposes?

A. Yes, it is.

Q. And do you know how much say, during the month of October, so we would be up to date, how much water is being used inside the mine?

A. I don't have any figures readily available on the monthly usage.

Q. Any water being impounded or stored within the mine?

A. Yes, there is.

Q. And how much water is that?

A. I wouldn't -- it would be too large to quantify, I'm not sure how much. On the usage, I do know that the average usage in mines runs between 10 to 20 gallons a minute.

Q. Okay. Nothing further.

MR. LAURISKI: Thank you. Mr. Mitchell?

MR. MITCHELL: Nothing.

MR. LAURISKI: Anything further?

MR. HANSEN: No, nothing further.

MR. LAURISKI: Thank you. Thank you, Mr. Reynolds.

MR. HANSEN: Co-op calls Richard White.

MR. LAURISKI: Does the Board have any questions of Mr. Reynolds? Thank you.

MR. FADDIES: I have one. The bore hole you mentioned, is it lined?

A. We're currently in the process of lining it.

Q. With what type of liner?

A. We're using corrugated metal pipe to line it.

MR. FADDIES: Thank you. That's all I have.

MR. LAURISKI: Any other questions? Thank you Mr. Reynolds.

RICHARD WHITE

was duly sworn, was examined and testified as follows:

BY MR. HANSEN:

Q. Would you please state your full name for the record?

A. Richard Bruce White.

Q. And tell us how you are employed, please?

A. I'm the president of Earth Fax Engineering.

Q. And are you a licensed engineer?

A. I am.

Q. Can you tell us a little bit about your educational background?

A. Sure. I received a bachelor's degree from Utah State University in 1976 in Water Shed Science, and then received a masters degree in civil and environmental engineering from Utah State University in 1977. Since that time I have been a consulting hydrologist beginning with the firm of Vaughn, Hanson Associates and then with Ford, Bacon and Davis, and for the past 12 years have been with Earth Fax Engineering.

My practice has been predominately associated with the characterization of hydrologic regimes. Much of my work is focused on performance of hydrologic investigations with coal mining operations in the Carbon and Emery County areas.

Q. I'm showing you our Co-op Mine's Exhibits C and D. Can you tell us what involvement you had, if any, in the preparation of those exhibits?

A. I was involved in the review of these documents. As a principal at Earth Fax, one of my -- one of the projects that I had overall responsibility for was the Co-op Mining Company project. So I was involved in technical assistance since the work was being performed to prepare these reports, and then was involved in the review of the reports and inhouse discussions as the reports were being reviewed.

Q. Are you familiar with the information contained in those reports?

A. Yes, I am.

Q. Last time we heard Mr. Garr state that there was one inaccuracy that as the reports were originally prepared, there was information indicating production of 500 gallons per minute of water in the mine, and that had not been updated. With that exception, are you aware of any inaccuracies in the past contained in those two exhibits?

A. To the best of my knowledge they are, with that exception, they are correct.

Q. Have you been involved in the permit application for Co-op mine to have a significant revision to mining in the Tank Seam?

A. Yes. To the same extent as I was involved in the preparation of these reports. As I indicated, one of my responsibilities has been to provide general oversight to this project, and in that capacity I also assisted in the -- in the review, and in the discussions related to the revision for the Tank Seam mining.

Q. And what impact will mining the Tank Seam have on Birch Spring and Big Bear Spring?

A. It's my opinion that mining in this Tank Seam will have no significant impact on the, either the quality or quantity of water in Birch Spring or Big Bear Spring.

Q. And why is that?

A. I base that opinion on the data that had been presented. The drill holes that were installed from the Blind Canyon Seam up into the Tank Seam, indicated that the zone between the Blind Canyon Seam up through and including the top of the Tank Seam were essentially dry.

Of the holes that were drilled, most of the holes yielded only a 10th of a gallon a minute water or less. One of the holes yielded half gallon a minute of water. Supporting that is also the results of the recent drilling of the shaft between the two levels, that Charles just spoke about. And the fact that also in that eight foot diameter bore hole, that intervening zone was also dry.

So the data indicates to me that the Tank Seam is basically dry, and as a result there will be no appreciable water encountered in the Tank Seam. Therefore, it's my opinion that there will not be any appreciable effect of mining in the Tank Seam on the quantity or quality of water in the Big Bear Spring or Birch Spring.

Q. What do you know about the relationship between the location of the Tank Seam and the location of the regional aquifer or water tables in the permit area?

A. The Tank Seam exists at an elevation about 200 to 250 feet higher than the Blind Canyon Seam. The drill holes that have been installed from the Blind Canyon Seam downward into the aquifer systems below, have indicated that throughout most of the area that has already been mined, the water table is below the base of the Blind Canyon Seam through the northern portion of that area that has been mined. There is a pressure surface in one of those members that comes up above into the Blind Canyon Seam at the northern most extent of the current mining. That's a pressure service and not a water table. So the only way the water could actually get there is if that confining layer that was holding that water under pressure was to be -- was to be encountered. But as a minimum, that puts the water level in the aquifer systems in the area, at least a couple of hundred feet below the Tank Seam.

Q. What about the water that Co-op mining encountered as we're mining the Blind Canyon Seam, in particular the water that has already been testified came out from the roof?

A. It's my opinion that that water is the result of encountering perched aquifers that are present within the Black Hawk Formation. It's not uncommon in the Carbon and Emery county areas in the mining operations for perched aquifer systems to be encountered. Generally the inflow to the mine that's been encountered at the Bear Canyon mine is inconsistent with the perched water systems where the water is coming in through the roof, and where that water -- the rate of inflow tends to slow down as the mining progresses. As you advance in the number of cross cuts, you tend to encounter water near the face of the active mining operation, and inflows behind you tend to decrease. And that's fairly consistent with what you would encounter in a perched aquifer system.

So it's my opinion that those are perched and are not part of that same system that is contributing water to the Big Bear Spring and to Birch Spring.

Q. Do you have any opinion as to the likelihood of contaminants being introduced in to the aquifer?

A. Yes, I do.

Q. What would that be?

A. It's my opinion that mining in the Tank Seam would not be introducing any significant quantities of contamination into the hydrologic system. The mining operations that have been conducted, I feel from my review, have been conducted in a manner that has minimized the potential for impact to the local ground water system. And it's my understanding that the same mining operations would be utilized in the Tank Seam, and so I have not seen anything that would indicate to me that there's any measurable potential for an impact to water quality occurring from the mining operations in the Tank Seam.

Q. Mr. Montgomery spoke of the possibility of contaminants being released, but he didn't say or identify what kind of contaminants might be released. Do you have any opinion as to what kind of contaminants Mr. Montgomery would have had in mind, or what kind of contaminants might possibly be released in to the water through the mining activity?

A. There are -- you have a potential for the introduction of oil and grease that may result from spillage, if you were to have some kind of a spillage in the mining operation. The rock dust that's utilized to control the explosive atmosphere in the mine can dissolve and add additional salts to the water. The primary factor that I think eliminates the potential for mining in the Tank Seam to impact the quality of water from Big Bear Spring and from Birch Spring, is the fact that there is no appreciable water that exists between the Tank Seam, no appreciable groundwater between the

Tank Seam and the Blind Canyon Seam. So there's no driving force there. Even if there was some sort of an event that would otherwise cause contamination to occur, there's no water there to drive it down. And past mining operations have indicated that there's no significant impact to the water that's being discharged from the Blind Canyon Seam from the mining operations. And so I would, from that, conclude that there would also be no impact to water that -- as a result of mining in the Tank Seam.

Q. Aside from the fact that there is no water in the area of the Tank Seam for it to be affected, because if it is removed from the aquifer or available to contaminants, do we have any other information to indicate whether or not Big Bear Spring is hydrologically isolated from the aquifer?

A. Yes.

Q. Or from the permit area, execution me.

A. Yes. The Tritium data that were discussed earlier in the previous testimony, indicate that the age of water from Big Bear Spring is significantly younger than the age of the water encountered in the mining operations.

Q. Tell us about the Tritium dating, what it is and how it works?

A. Tritium is an isotope that -- an isotope of hydrogen that was increased in concentration in the atmosphere from the early 1950's until the early 1960's as a result of open air atomic bomb testing. Once that testing stopped, there was no more artificial introduction of Tritium into the environment. Any time that you run into concentrations of groundwater where Tritium concentrations are elevated, that's an indication that the water is of a relatively young age compared to waters that have a much lower Tritium concentration.

The water from Big Bear Spring, Tritium concentrations there are approximately 10 times greater than the Tritium concentrations in water that's encountered in the mining operation. And so that would indicate to me that the Big Bear Spring has a source that is different than the source of water for the mining operation, and that the two were not hydrologically connected.

Q. Is that conclusion also consistent with what we know of the presence of the Mancos Tongues and the water tables separating between the Mancos Tongues and underlying regional aquifer?

A. Yes. The water levels in the three separate tongues of the Star Point Sandstone which underlie the

Blind Canyon Seam, the aquifers that were encountered during the drilling of the holes from the Blind Canyon Seam downward, as I indicated earlier, that water, as you go to the north, that water is under pressure, and rises above the confining layers.

The tongues of the Mancos Shale which interfinger with the Star Point Sandstone in that area, serve as confining layers, and so that water, as you go north ward, is under confined conditions, rises in a well above the top of that Sandstone Tongue.

And any time that you have water that's under pressure such as that, that's normally an indication that the source of recharge is not immediately at that point, but the primary source of recharge is somewhere up gradient to that point where the water can get into, into that unit. And then as it flows down gradient, and gets into an area that's -- where that confining layer is over lying it, it's at that point that it becomes confined. And so that would be at some point up gradient or north in this case, would be the primary area of recharge for Big Bear Spring, and Birch Spring and the other springs around there that are receiving their water out of these tongues of the Star Point Sandstone, rather than that recharge coming from the immediate area of the mine.

Q. Do we have any other information to show whether or not Birch Spring is hydrologically isolated from the permit area?

A. Yes. In water quality samples that were collected from Birch Spring, the Tritium data indicated Birch Spring was also relatively old water. But the chemical data obtained from Birch Spring compared with the water from the mining operation, indicated that there was a significantly higher concentration of sulfate from Birch Spring, and that the waters that were discharging from Birch Spring were chemically dissimilar to the water that was contained in the mine.

If the mine was to be up gradient from Birch Spring, and if the water flowing through the mine was to eventually find its way to Birch Spring, you would expect that the chemical signature of those waters would be fairly similar. And yet, the elevated concentration of sulfate in Birch Spring indicates that those waters are not chemically similar. And that they therefore have different sources.

Q. Are there any other elements of the chemical analysis that would further support that conclusion?

A. Those are what come to my mind immediately.

Q. If we could take a minute. I'd like to briefly refer everyone to Exhibit D.

MR. CHRISTENSEN: Which Exhibit?

MR. HANSEN: D. Maybe I just need clarification on this point. Turn first to page 2-39.

Q. Can you tell us what that page describes?

A. Yes. Those are a summary of results of analytical data from samples collected from Birch Spring, it appears, in 1987, 1989, and 1991.

Q. And then if you could tell us what we see on pages 2-31 and 2-32.

A. 2-31 and 32 is a summary of data obtained from the inmine monitoring wells, chemical data.

Q. And are there also, in addition to the sulfates, do these three tables show other chemical differences between the water in Birch Spring and the water that's encountered in the mine?

MR. SMITH: I object. I'm unclear on what we're doing. We're looking quickly at tables, and then -- I'm confused. I guess my objection is I don't know what they're doing, so I can't even make a sensible objection, because he's calling for conclusions after we look at a table for five seconds.

MR. APPEL: I'll object and join in that on lack of foundation. We don't know where these inmine samples were taken, we don't know what lab did it, we don't know anything about chain of custody for these samples. And on that basis to draw a conclusion would be very unfair to us.

MR. HANSEN: Well, Mr. White already testified without objection that the information contained in here in this exhibit is accurate. If on cross-examination they would like to question the accuracy, that's fine.

MR. LAURISKI: Yes, and also note that both of you agreed to allow these exhibits, this exhibit to come in without objection. So, I think to provide an opportunity to cross examine Mr. White on those tables would be more appropriate and I'll overrule the objections.

BY MR. HANSEN:

Q. For example, I'd like to call your attention to a couple of entries. On page 2-32, there's an entry on the inmine water referring to TDS, that is total dissolved solids?

A. Yes.

Q. And 2-39 there's a similar entry for TDS for the Birch Spring?

A. Yes.

Q. And it would appear that the water from Birch Spring is significantly more salient than the water encountered in the inmine monitoring wells.

MR. CHRISTENSEN: What are we looking at, bicarbonate or --

THE WITNESS: What he's referring to on page 2-32, the top line, top analyte there is listed as TDS, and comparing that over on page 2-39 with the third line down, that says TDS.

MR. CHRISTENSEN: Okay.

THE WITNESS: And comparing those two sets. Total dissolved solids, measuring the general salt content of the water.

MR. CHRISTENSEN: Thank you.

BY MR. HANSEN:

Q. And would we be able to make similar comparisons of other elements from the two sources?

A. Yes. We may be able to, but I would need to sit down and take some time with the tables to make some comparisons, but that may well be possible.

Q. I don't want to take up everyone's time with performing that kind of analysis. The information exists as it is in the tables.

Mr. Garr, and I believe Mr. Reynolds, mentioned the existence of a fault on the west side of the permit area east of Blind Canyon. Can we draw any conclusions from the existence of that fault?

A. Are you referring to the Blind Canyon fault?

Q. Yes.

A. Yes. That's a fault that exists basically along the -- as I recall, on the western, just west of the permit area, but east of Birch Spring. So the fault runs between the mining operation and Birch Spring.

Q. How far away is the fault from Birch Spring?

A. As I recall, off the top of my head, it's about 800 feet from Birch Spring to the fault.

Q. Now, if that fault was open and allowed water to flow through, would the water entering that fault flow into Birch Spring?

A. No. In either case, whether the fault is serving as a conduit is open and is a pipeline basically for water, or if the fault is serving as a barrier to the flow of water, in either case, that fault would serve as a barrier for the flow of water from the mining operations over toward Birch Spring. If it was serving as a conduit, then any water that was flowing to Birch Spring from the mining operation would be encountered by the fault and would be conveyed along the fault. If it was serving as a barrier, then water flowing towards that fault would hit that barrier and would not be able to flow through, and it would be turned and flow again down to the south along that fault.

Q. Mr. Montgomery relied considerably on information in some U.S. Geologic survey reports. I note that Exhibit C and D contain a considerable amount of cited information. Why didn't your Earth Fax rely on those same reports?

MR. SMITH: I object, we're having comments about the evidence by counsel, and I object to that. He can ask questions, but shouldn't comment about what evidence is contained in these various reports. So I object to the form of the question.

MR. HANSEN: I did not comment on the evidence, I just recalled a fact.

MR. LAURISKI: Just rephrase the question, Mr. Hansen.

BY MR. HANSEN:

Q. Why did Earth Fax rely so heavily on site specific information and to a lesser extent on the U.S. Geologic survey reports?

A. We felt that the U.S. Geological survey reports were a good indicator of general conditions in the area, but felt like it was of most value if we could obtain site specific data. Site specific data would be much more indicative of what would be happening at the Bear Canyon mining operations. Therefore, as we discussed the data we felt would be necessary in order to better characterize hydrologic conditions at the Bear Canyon mining operations, Co-op Mining Company agreed that it would be valuable to collect the site specific data so we could know what was happening on-site as opposed to merely drawing our conclusions from the regional reports that had been prepared.

Q. Would mining the Tank Seam result in sealing off any faults and fractures in the existing area creating an impermeable barrier for any additional water flowing down?

A. I don't believe it would.

Q. Why not?

A. Any mining activity that occurs -- the only area where you've got any significant traffic occurring, is directly in the man ways. That mining operation is conducted on -- normally there's coal left on the floor. You have a much better floor to the mine if you have coal on the floor, so there's coal left there. That coal is generally somewhat friable, and mere driving of vehicles across that floor in my opinion does not create an impermeable barrier, vertical barrier at the floor.

Most of the area actually is left in pillars. Then in retreat mining those pillars are pulled, and there's essentially no traffic in the area where those pillars are. During the immediate time that the pillars are being pulled there's no repeated traffic over that area, and so there's really no potential there during the pulling of those pillars for any compaction to occur. There's no, in the floor of the mine, there's no significant amount of clay that you would be compacting into a fractures that would create any impermeable barriers. So I don't believe mining in this Tank Seam would create any impermeable barriers to water.

MR. HANSEN: I believe I have no further questions at this time.

MR. LAURISKI: Quickly while we're on the subject, what is the floor lithology of the Tank Seam?

THE WITNESS: I would have to look through the drill logs to make sure, but as I recall, what's right below the Tank Seams are sandstone members of the Black Hawk Formation.

MR. LAURISKI: Thank you. Mr. Smith? Mr. Mitchell, you have anything?

MR. MITCHELL: Nothing.

BY MR. SMITH:

Q. Yes. I have a couple questions about -- I'd like to refer your attention, Mr. White, back to Exhibit D and to page 2-39. That's, I guess, some analytical testing of the Birch Spring, and you testified about the total dissolved solids and I think you compared, if I recall, Birch Spring total dissolved solids to some wells or water that was taken from the mine; is that correct?

A. Yes, that's what we're doing.

Q. It seems to me that the water quality, according to your tests, has changed quite a bit in Birch Spring over the three tests that were done there going from 400 to 800 and back to 400; is that correct?

A. Other than the fact these are not our tests; these are data that were provided to us, as I recall, from the water companies. But yes, the data do indicate there has been a fairly -- there has been a change in the quality of that water on those three events.

Q. I would assume water quality to change, mountain mine water as well at different times could be different water quality?

A. There are always naturally occurring changes in the quality of the water, yes.

Q. You have no reason to believe this data is incorrect; you include it in your report, right?

A. That's correct.

Q. Going to page 2-32 which is the chart on the mine quality water, do you know when those tests were taken, on what date? Compare apples to apples here, if you can compare dates.

A. These wells were sampled in May of 1992.

Q. So that's at least a year different from any of the dates of the Birch Spring tests?
A. That's correct.
Q. Do you think that's a fair comparison?
A. Sure.
Q. Even though it could double or half or whatever, as it did in Birch Spring?
A. I think any time the more data you have the better, but I think this is a reasonable comparison for the general conditions that you would expect to encounter in Birch Spring versus the water encountered in the sandstone members that underlie the Blind Canyon Seam.
Q. And because -- as I recall, wasn't the Tritium testing that you used to differentiate Birch Spring from the mine water, it was a chemical analysis, isn't that correct, the Piper and Stiff?
A. Yes, that's correct.
Q. You couldn't differentiate those, correct?
A. That's right, but the Tritium data indicated in both cases that the water encountered in the mine and the water encountered in the Birch Spring were relatively old.
Q. But seems like the chemical composition can change quite dramatically, I would say a double change,

and then doubling from 412 to 810. That's a very dramatic change in chemical composition in Birch Spring, yes or no?

A. Yes, that's correct.

Q. Okay. That doesn't call any questions into your mind about whether you're differentiating the water on a chemical basis is valid or not?

A. As I recall, I'll have to look back through to verify, but as I recall, we -- in fact, if you want to give me a minute, let me look through and see what we used in that chemical comparison.

These were average analytical data that we used in the preparation of the Piper diagrams and Stiff diagrams.

Q. Average of what?

A. In the case of Birch Spring, we used data from eight samples, averaged the data together in order to get the points.

Q. What were the dates of the eight samples?

A. I'll have to look back through the original data.

Q. So you don't know?

A. Not sitting here, no, I do not.

Q. We're here today having the hearing and we have to know what you know today, not what you may have known or would know at some other time. So you don't know what the dates of the Birch Spring samples were that were used to differentiate the Birch Spring water from the --

A. It would appear here, it says results of the sampling in 1991. So these were data obtained in 1991, and eight samples from Birch Springs that we used in the preparation of that Piper diagram.

Q. When was the mine water sample, same time?

A. I believe I just indicated it was May of 1992. Oh, wait. You're talking about the mine water that -- which mine water?

Q. The mine water that was used for, you know, for your chemical, Piper and Stiff diagrams you have used as a basis to say these are different waters.

A. Those were also collected in 1991, for the generation of the Piper diagram and Stiff diagrams. We used data from the same time frame.

MR. LAURISKI: This was for the purpose of the Tritium levels?

THE WITNESS: No. Excuse the confusion here. What we're comparing now are the Piper diagrams and Stiff diagrams that appear on page 2-27 through 2-29 of Exhibit D. They're a representation of chemical data, and I was being questioned as to whether or not we're looking at similar time frames for the chemical data that went into those figures. And yes, they were, they were all data collected in 1991. That again is separate from the Tritium data.

This is just looking at chemical data, all collected within the same, within the same year. And we utilized the available data base for each of those points collected during that year, so we're trying to compare as closely as possible, data from the same time frame. So in case there were oddities for whatever reason, due to this temporal variation, we would hopefully be able to remove those oddities by looking at data from the same time frame.

BY MR. SMITH:

Q. Was there any attempt to -- let me ask this. Water moves very slowly through rocks; is that correct?

A. In this area, yes. The flow of groundwater is relatively slow.

Q. And so, since the mine and Bear Spring are at least a little bit separated apart, did you do anything to try to get the water, same age water?

A. I really can't, within the time frame that we have. As I recall, from the hydrologic tests that were conducted in the inmine monitoring wells, the travel time from the mine to the Birch Spring area was on the order of one or 200 years. And so, to try to say that this is water that would have gone underneath the mine at the same time, we would have to wait for that time frame. So all we could really do in that case was say that these waters that we're encountering now, are a function of whatever history they have been through. And in trying to compare, in this case, we're trying to see if there was anything that indicated that waters may be of a similar source or a different source.

Q. What was the chemical difference between the Birch Spring water and the mine water?

A. As I recall, the primary difference was that the Birch Spring water contained significantly higher sulfate concentrations than the mine water.

Q. But directing your attention to 2-39, in just your time frame, the sulfates had a three time or went from 100 to 298 back to 120, in the three tests?

A. At Birch Spring?

Q. Yes.

A. Right.

Q. So, just because you took some tests in '91 of Birch Spring water, it's very difficult to say that's the way -- the water certainly isn't that way all the time?

A. It is interesting that the time frame we utilized was in the low end of that range when sulfate concentrations were lower, and those sulfate concentrations there at Birch Spring were still higher than elsewhere.

Q. But they were not, they were quite a bit higher than they were in 1987. When you say the low end, you're -- it would be 129 milligrams per liter, where a few years earlier it was only 102?

A. Again, we had to use data from an overlapping time frame so we -- so we could minimize to the extent possible any temporal effects. And data we had were from 1991, and the -- at least the sulfate data from the one sample that's presented here, is indicative of the lower end of that range as opposed to the higher end. And again, sulfate concentrations were the things that were the highest in the Birch Spring water as opposed to being something that was significantly lower.

Q. Now, since that was the difference, it seems like at least one of the samples, and I direct your attention to 2-32 of the sulfates in the mine water, was identical to the Birch Spring water, 128 as compared to 129?

A. The one thing you need to remember, is that the data on in table 2-6, which is on pages 2-31 and 2-32, those are samples that were collected from the inmine monitoring wells which are monitoring the Star Point sandstone below the mine. Those are the things that feed into the -- where water from those tongues of the Star Point sandstone feed into Big Bear Spring and feed into Birch Spring.

The mine water that we're comparing in the Stiff diagram is the water that actually is encountered in the mine. The data from table 2-6, those -- that water is not encountered in the mine, it's merely monitored by wells drilled within the mine, but water below the mine. And the water that is compared in the Stiff diagram is water that has actually flowed into the mine and has been sampled.

Q. And do we have the results of those chemical tests in any of the exhibits that we have here today?

A. I'd be glad to look through here and let you know.

There's at least some data presented in table 2-5, which is on page 220 of Exhibit D. Let me look on the other exhibit. I believe in Exhibit C there are some analytical results that are presented on page 2-16, 2-17, 2-18. It appears out of these two exhibits, that's primarily what we have for the water quality on the water flowing in to the mine.

Q. Does that have the sulfates in it?

A. Yes, there are sulfate data there.

Q. For those of us not as good on the atomic --

A. Go across the top.

Q. On the chart, the --

A. The 4th column from the right, it says SO4. That's the sulfate. And if you'll look down on page 2-16, look down the last three rows, roof drips, above Su 1, above Su 3 and SBC-1, you can see sulfate data there. Similar on the next page, next couple of pages have similar sulfate data reported.

Q. Now, I have a question about these inmine monitoring wells. What water do they -- this is back on 12-32, what aquifer did those wells go into?

A. Each of those wells is completed in a -- there are multiple completions. Each of those -- no, each of those monitoring wells is completed in a different member of the Star Point Sandstone.

Q. I see.

A. There are three different members of the Star Point Sandstone beneath the mine workings. And again, for reference, all of this discussion is below the Blind Canyon Seam that we're talking about now. The Star Point sandstone has three different sandstone units in it that are separated by shaley tongues of the Mancos formation, and so those monitoring wells were completed in one -- each in those three different tongues.

Q. And help me if you can on this, where is the area of recharge for the Star Point Sandstone aquifer?

A. It would appear to be north of the -- primarily north of the mining operations, north of the permit area.

Q. Is that the same location as the recharge area for the Black Hawk water that's found in the Black Hawk Formation?

A. Yes, there's going to be some. Yes. I would assume the Black Hawk is also recharged up in that area.

Q. And so the water that goes into the Star Point formation at some point has to go through the Black Hawk Formation?

A. In general terms, yes, because the Black Hawk overlies the Star Point.

Q. And if -- okay.

A. The difficulty in understanding that, is that there is -- there's a zone. At a minimum there's at least one zone up north of the permit area that was referred to in previous testimony as the shattered zone where there is a significant amount of fracturing that has occurred. And so as water up on that plateau melts, as the snow melts and you get water that percolates down through the subsurface, until it comes down and encounters something that's going to serve as an aquifer in an area that's highly fractured, the resident time for that water may be fairly short. So it's not like it has to make its way down through a significant amount of number of sandstone lenses and shale lenses within the Black Hawk Formation before it reaches the Star Point Sandstone.

Otherwise you wouldn't be getting the apparent younger aged water from the Big Bear Spring, as compared to water that you encounter higher in the -- stratigraphically higher in the mining operations. So, it's likely that a fair amount of recharge occurs back in that shatter zone, that again being a few miles north of the permit area, and that that water percolates down and probably gets into the Star Point Sandstone back up in that area.

Q. Okay. I'd like you to look at page 2-6 of Exhibit C which is the Probable Hydrologic Consequences. I'd like to ask you some questions about some different points from these exhibits so I understand.

I'll read from the very bottom of that page. It says, "Star Point Sandstone together with the lower Black Hawk Formation, the Black Hawk/Star Point aquifer is considered by Lines to be a regional aquifer."

That's from one of the USGS studies, isn't that correct?

A. Yes, that's correct.

Q. Mr. Lines grouped the Black Hawk which is next to the Star Point together with those two aquifers and considered it to be a single aquifer?

A. That's correct.

Q. And I'd like you to look at page 2-9, and it says, middle of the first paragraph on that page, "There's no springs in the permit area," that's correct, right?

A. Yes. I was trying to find out where you were reading.

Q. And from there, going down four lines. "The two largest springs in the area are the Big Bear Spring and Birch Spring, are associated with faults and joints and issue from the Panther Tongue of the Star Point Sandstone."

A. Yes.

Q. That's correct?

A. Yes.

Q. As I understand it, both of those springs are there because there's a joint or a fault?

A. That's correct.

Q. In that location.

A. That's correct.

Q. Have you done any investigation to see where that fault goes or how big the fault is for those two springs?

A. Personally, I have not. I'm not a geologist, I'm a hydrologist, and I have not personally followed the joints there. Generally I can tell you that joint systems individually tend not to be highly laterally continuous. You have a joint system, you have a general trend of joints, but you cannot typically trace a joint like you can trace a fault where you may be able to trace the fault for several miles. With a joint, joints tend to be much shorter and are associated with multiple other joints so to be able to track one joint back tends to be rather difficult.

But I'm assuming that the joint system is going to be, and as typically occurs, the joint system is coincident with the geological conditions, and so those are generally going to run north and south just like the fault systems run.

Q. Do you know how much vertical, how high vertically the joints may extend for those two springs?

A. No, I don't.

Q. So you don't know if they would go up into other -- they would go above the Panther Tongue, or whether they would just be combined with the Panther Tongue?

A. I don't know. I can tell you generally in the area, joint systems do not extend through the shaley layers of the Mancos. The Mancos tend to be fairly plastic, and so the tectonic events that would have created the joint systems, unless it was sufficient to create a significant offset, typically those joint systems do not go up through the Mancos tongues because it is plastic enough that during that tectonic events it would have molded as opposed to cracking and allowing the joint to extend on up through it.

Q. But at some point, something has to have gotten through the Mancos tongues. If it didn't, there would be no water here to feed these springs.

MR. HANSEN: Objection, counsel is trying to testify here himself.

BY MR. SMITH:

Q. Do you agree or disagree?

A. You're making the general assumption the Mancos tongues are laterally continuous, which they're not. Typically the tongues of the Mancos that are encountered out in that general region, tend to be rather limited in their aerial extent. So what you're assuming is that those tongues extend back up in to that area where the recharge is occurring to the Star Point Sandstone, and I don't think that that's a safe assumption to make.

Q. And I don't want to make a wrong assumption. Do you know where those tongues end?

A. I don't. I have no data to indicate where they go, however, you're correct in your statement that there has to be a source, there has to be a place where that water can get into the system.

Q. It's coming down from above?

A. Yes, that's correct. And so that tells me that at some point up gradient, those tongues are nonexistent, so that you've got a condition that would allow the water to percolate down through that overlying rock and get into the Star Point Sandstone. And it is typical that tongues elsewhere around that general area, that tongues that occur are relatively aerially nonextensive which you don't find over multiple miles with a tongue.

So, again, I would conclude that that shatter zone is a probable area of recharge, and that it's very likely that those tongues don't exist back up in there, and that's allowing fairly easy access for the water to percolate down into that sandstone. Even if the tongues did exist, that shatter zone has been tectonically altered enough that the fact that the water is under pressure tells me that the water is able to get in at that higher elevation. And that if those tongues do exist back there, that tectonic activity would have been sufficient to cause fracturing to go through the tongues.

However, for what it's worth, I really don't think that tongues go back up there, because again, the Mancos tends to be benetic (sic) and whatever fracturing occurs, it tends to seal itself off. So that would preclude water from getting in to the Star Point.

Q. And the tongues, there were three test wells drilled and that's how they were discovered?

A. Yes.

Q. Any other tests to determine the extent of those tongues or where they are other than those three?

A. We've looked at, of course, surface outcrops. But going back into the mountain, those are the only data that we have at this time.

Q. Okay. I'd like to direct your attention to page 2-10 of the hydrologic consequences. Do you know why initial spring and flow rates weren't listed here for Big Bear Spring and Birch Spring? It has NM, not measured. Do you know why that doesn't appear?

A. I don't know. I can read through and see if there's any indication here. I would assume, again, these were data that were -- I believe what this table was doing was presenting the initial data, the earliest data that were available. And since these data were provided by others, by the water companies, I would only assume that they had some indication of activity at those springs, but did not have a flow rate.

Q. You say initial, is that baseline data?

A. Yes.

Q. That we're talking about?

A. This would be the first set data that were collected at each of these particular points. A true baseline would include some more data, but this would be the first bunch of information that would have been collected there.

Q. Okay. I'd like to direct your attention to 2-13 of the PHC.

MR. LAURISKI: Are we still on Exhibit C?

MR. SMITH: I'll try to do it in order. We'll do C and a little bit on D.

THE WITNESS: Which page?

Q. 2-13, the bottom paragraph. I think we've talked a fair amount about this with the previous witness. I don't know if we have to spend much time. That talks about a dramatic increase in flow that happened into the mine. Do you know how much water is currently inflowing into the mine at this time?

A. Just generally. The general indications back in October, when the corrections were made to these documents, were that there was about 100 or 210 gallons a minute that was --

Q. That's what's being discharged?

A. That was what was flowing in to the mine in October, of which 180 gallons a minute, approximately, was being discharged from the mine. And approximately 30 gallons a minute was being used underground.

Q. Any measurement of these? Do we have any meters or flumes or anything to measure these?

A. It's my understanding, at least on the discharge, yes, there are measurement methods. Underground, that's difficult to measure because it's used in a variety of sources, so it can only generally be estimated based on the consumption of each piece of equipment.

Q. We heard testimony earlier today about there's a storage area of water in the mine. Are you familiar with that?

A. Yes.

Q. Do you know how much water is being put into storage?

A. I do not.

Q. So you don't know how much water is being put into storage. So, how do we come up with how much water? Why don't you tell us again, so I understand. I'd like you to talk about each -- I understand there's three things you are using water or in the mine, some is being put in storage, some is being used for mine uses, and some is being discharged.

A. That's correct.

Q. Do we know what those three are?

A. Generally the -- at this time the storage, the amount of additional water are going to storage and generally be assumed to be zero. The storage areas are generally full, and any additional water that is encountered, typically, merely routes through those storage areas. And so you basically have inflow equaling outflow.

During initial construction of a sump area underground, you're not going to have discharges from the mine at the time you are filling the storage areas. But those have been in use long enough now, that any inflow to the storage areas is basically coming out as outflow. So, I don't believe there's any significant amount of that that's being lost to storage.

So as I review the data, I would still indicate that there's about 200 gallons a minute of water that's encountered, and about 20 or 30 gallons a minute of that is used underground, and the remainder is discharged. Charles indicated that there have been some additional decreases in that flow, and that the amount being discharged now is about 140, as opposed to 180 gallons a minute.

Q. Do you know how much water that is, 140 gallons a minute over a year, do you know how much water that is?

A. I can easily calculate it if you want me to.

Q. Maybe just give an estimate.

A. I'd have to.

Q. You'd have to times it by 60, and then times it by 24, and then times it by 365.

MR. HANSEN: I object, counsel can do the calculation. It's not really relevant in any case.

THE WITNESS: Do you want me to calculate it?

MR. SMITH: I don't think we need to do that.

THE WITNESS: Okay.

Q. Page 2-14, same exhibit. Birch Spring and the mine water, we have waters can be distinguished on Tritium analysis?

A. That's correct.

Q. At the bottom it says -- of 2-14, it says, "The age of water from Big Bear Spring cannot be determined."

A. Yes, the --

Q. Can you explain that? I'm confused.

A. The Tritium that's indicating that, the data do not allow us to put an exact date on the age of the water. We can't give you a year that water hit the water table based on our existing data. We can tell you relatively that the water issuing from Big Bear Spring is significantly younger than the water that's encountered in the mine, but we can't put a date on either of those, just give you relative ages.

Q. Go to page 2-22. I'm sorry, 28. I'm sorry, I'm sorry, 2-22. 2-22. And that's the Piper diagram; is that correct?

A. That's correct.

Q. And based on the Piper diagram you can't distinguish between the water that's in Big Bear Spring and the mine water?

A. That's correct, based only on the Piper diagram.

Q. Now, go to page 2-28, first paragraph. In the second sentence, water from DH, drill hole #2, has calcium; is that drill hole #2?

A. Yes.

Q. Has a calcium, magnesium, sodium potassium-sulfate pattern. This pattern is distinctly different from the groundwater that has been sampled in the permit and adjacent areas, and is presumed to be due to the dissolution of locally occurring sulfate salts.

Is that correct?

A. Yes.

Q. So chemical components of water can be affected by something that's right there in a local area.

A. Yes, that's correct.

Q. And so, for example, Birch Spring could be affected by locally occurring sulfate salts near where it issues from the rock?

A. That's a possibility, although you would expect to have seen some other effect on other constituents as well as just the sulfate, if that was the case. One of the things that needs to be remembered in evaluating the data, and that are discussed here on page 2-28, is that each of those wells, again, is completed in a different sandstone unit. And while those sandstone units are hydraulically or probably hydrologically connected somewhere back up near the recharge zone, they are currently distinct and are not hydrologically connected to one another.

So what's local to DH2, the term "local" here is relative and I would not want that to be interpreted as saying something that's within a 50 foot radius or relatively small radius. This is a unit that, again, appears to be somewhat aerially extensive, at least beneath the mine workings. And so the mine workings that the water has had to flow through before it's gone to DH2, could have significantly changed what's happening. What you see at DH2 versus what you see in DH1, 2 and 3 because these are hydraulically separated.

Q. Did you do any further testing of the Birch Spring to try to determine whether there was any locally occurring sulfates in the area of Birch Spring?

A. You are wondering about sampling of the rock and that sort of thing?

Q. Yes.

A. No, we have not.

Q. I'd like to have you now, move to Exhibit D, and go to page 2-4 of Exhibit D. And on the second paragraph if you're there on that page, I didn't understand the paragraph, and I would like maybe to get that clarified. The Black Hawk, Star Point the Blind Canyon Seam is about 100 feet above the Black Hawk Star Point contact; is that --

A. That's correct.

Q. That's correct?

A. Yes, the Blind Canyon Seam, there is a coal seam that sits right on top of the Star Point, but that's not the Blind Canyon, that's the Hiawatha Seam.

Q. That's the Hiawatha?

A. Yes.

Q. That seam has not been mined in this area, I take it, or has it?

A. In the area, it has. Whether it's been mined right in the Bear Canyon area, in the past, I'm not sure.

Q. You don't know?

A. I'm not sure.

Q. Okay. I'd like to go to page 2-11.

MR. LAURISKI: Can you, Mr. Smith, tell us what 2-11 is? We seem to be missing that. Some of us, anyway.

MR. SMITH: I'll read it. It's just the current groundwater. Must not have been copied.

MR. HANSEN: Mr. Chairman, I had this document copied in your library and took it to Kinko's and found out afterwards a couple of pages may have been omitted from the copying, and it's possible those are the pages.

MR. SMITH: I'll read the last sentence out loud on that page.

MR. LAURISKI: I can share here.

MR. SMITH: It says on 2-11, the fact that the Star

Point aquifers are separate, hydrologically distinct, a single water table does not transect the stratigraphic units as proposed by Danielson et. Al., in 1981. Suggest the regional aquifer in the study area is actually located below the Star Point Mancos Shale contact."

Are we talking about below the Star Point aquifer?

A. I think the concern that we have, we had an inhouse -- had a rather lengthy discussion about the use of the word, or term regional aquifer out in this area. As you indicated, I think as we've discussed a little earlier, and as you read in a portion of this, Greg Lines in his USGS publication on work that he performed in the Trail Mountain area, which is south of here several miles, came to the conclusion that the Star Point and Black Hawk aquifer, Black Hawk formations can be viewed together as a single aquifer, the Black Hawk overlying the Star Point. And as you go deeper into the mountain, the water table tends to rise. And so both the Black Hawk and Star Point become saturated, and they're viewed in some areas down there as one system, and as typically referred to as the regional aquifer.

As we drilled the holes from the Blind Canyon Seam downward into the Star Point Sandstone to try to gather some local data, we found as it was indicated here, that there are distinct aquifers, three separate saturated systems, each corresponding to a different tongue of the Star Point Sandstone. And that that typical regional aquifer that Lines was defining did not exist here. We did not have one saturated Star Point Sandstone unit with that water table rising up into the Black Hawk Formation, and in fact did not even have one distinct, just Star Point Sandstone aquifer.

And as we discussed inhouse, the appropriateness of the use of the word regional here, we felt like it was difficult to conclude that this was the same regional, if you will, aquifer, and that's why it's in quotes. That has been discussed by Lines and others in that area. And we felt that based on a review of geologic data in the area, and from our experience elsewhere, that there was no regional aquifer above that point.

And so if there was here, a regional aquifer in quotes, that that had to be below this. I think it's really just a point of semantics, I think, that if Star Point is generally considered to be eventually contributing to something that might be termed a regional aquifer, it's just that in this area, it cannot be defined as being the same thing that it's usually defined as elsewhere with the coal mining operations in the region.

So, we didn't feel that it was appropriate to use that term, and yet in conducting hydrologic characterizations of coal mining operations, the regulatory authorities are normally interested in seeing what the effect is going to be on a regional aquifer. We didn't feel there was one here, and so we were stating that if anything like that exists, we haven't encountered it.

Q. You don't think there is a regional aquifer in this area?

A. Well, again, it's -- it becomes, and this is why we had so many discussions inhouse, it really becomes a matter of semantics, of what is a regional aquifer. How aerially extensive is this thing supposed to be. What we've encountered was a condition that was atypical of what had been described elsewhere in the Carbon and Emery county area. And so, whether this contributes to something on a regional basis or not, I don't know. We don't -- we didn't feel that it was worth the time and effort to follow this off the permit area in order to answer that kind of a question. We knew what was happening beneath the permit area, and felt like we had a good enough handle on what potential impacts would be on mines in this permit area.

And so whether this contributes to something on a regional basis, I don't know. It may well, it may not.

Q. So then do the -- does big bear and Birch Spring, do they issue from a regional aquifer?

A. They issue from the Panther Tongue of the Star Point Sandstone.

Q. So --

A. You know, whether that's part of a regional aquifer or not, I don't know. Again, it's just a matter of semantics.

Q. Just so I understand, when you are saying the regional aquifer may be below the Mancos Shale, that's a very thick, 600 foot thick of impervious rock. That's pervasive throughout that whole area?

A. That's correct.

Q. This underlies the valley of where the -- in Emery County and Carbon County, in other words that whole area?

A. That's correct. Although there are tongues in the Mancos Shale that are considered to be aquifers also, and so, again, we got into this discussion that became a semantics issue, and what is regional and what isn't. This was a condition that appeared in the area of the Bear Canyon mine permit area. We didn't want to infer from that that this was necessarily what was happening for several miles around the Bear Canyon permit area. We wanted to make sure it was clear that we knew that this was what was happening locally.

Whether or not this was happening regionally, we didn't know and really didn't want to get in to that, and so we're just saying here that we don't know if this is part of it. And it largely becomes -- we felt like it was going to become academic to answer that question.

Q. Okay. Let me direct your attention to --

MR. LAURISKI: Mr. Smith, how much longer do you anticipate.

MR. SMITH: I'm almost done.

MR. LAURISKI: I think we probably need to take a little bit of a break. If you are going to be done in five minutes --

MR. SMITH: I will be.

MR. LAURISKI: Okay. Thank you.

BY MR. SMITH:

Q. Page 2-38. Your report reports an event of increased flow and decrease in water quality, in this paragraph, in 1989, both in Birch Spring and also within the mine itself. Do you have any explanation for that, those things happening at the same time in the mine and also in Birch Spring?

A. No. We indicated in there that there's -- we could not come to a conclusion, that normally if we had said that those were synonymous, the results of the increased inflow into the mine was something that was associated with the increased inflow in water from Birch Spring, we would have expected the quality of the water in Birch Spring, the TDS to decrease rather than increase, because the mine inflow was a better quality water. And so, we would have expected that if it was the same event, that there would have been dilution.

And so as we evaluated the data we could not find a correlation between them.

Q. Doesn't it seem extremely coincidental that we would have increase in flow in the mine and Birch Spring if there wasn't some common course or interconnection between those two sources?

MR. HANSEN: Objection, argumentative.

MR. LAURISKI: I'll let him answer the question.

THE WITNESS: It definitely seems coincidental, but again, as we evaluate data, we could find no reason for the two to be associated with one another. And as we evaluated the data, we said if they were associated, different things should have happened, and we could not find that correlation, as I remember.

Q. I want to show you these exhibits. This is the 1980 to 1994. I think this is Exhibit 15 or 16.

MR. HANSEN: I'll make an advanced objection to any examination on these exhibits, both on the grounds of relevance and also as exceeding the scope of direct.

MR. LAURISKI: Mr. Smith, any response?

MR. SMITH: I don't think they exceed the scope of direct. There are similar charts in their D and C that they have here. I think they're relevant, because he's testified he doesn't think there has been any impact, or will be any impact on these springs by the mining activity. And all I want to ask, I've got one question for each, if he has any explanation.

MR. LAURISKI: Well, where does all this take us to the Tank Seam?

MR. SMITH: Well, I think it takes us to the Tank Seam because I think your -- well, and I've got this maybe from my closing and if you ant to hear my argument I'll give it now, but I think -- well, let me put it this way. When we were here before, I think we got -- I heard let's try limiting our scope to the Tank Seam. I don't think that's the purview of this Board. I think this Board has to look at, under the regulations that are before this Board, and I want to specifically refer to regulation R 645-300-211. This Board has a broader purview than looking just at the Tank Seam. I think this Board has a broader responsibility to look at whether the renewal or the issuance of this significant revision to the permit will, has or will adversely affect the water users that are here today.

And I, you know, I respect the comments of the Board and the opinions of the Board on this, but I have to also respectfully point out that the purview and the requirements to review this are broader than that. And if the granting of this significant revision will have any adverse impact, then that's what this Board needs to look at, not whether one aspect of it, the Tank Seam, is going to have an adverse impact.

It's been put into evidence, Mr. Chairman, that this will extend the life of this mine for three additional years beyond the current life. That the water discharge will continue throughout the same working, same mine. And so I respectfully point out the Board has to go beyond what's in the Tank Seam itself, and look at whether the issuance of this permit will have an adverse impact. And that's the charge of this body, and we submit that it does. Obviously this is argument, but that's my answer to your question.

MR. LAURISKI: I guess that's where I'm at a loss, and correct me if I'm wrong, but your petition for review was for review of the significant revision to the permit which allowed -- which allows Co-Op to extend their mining activity in to the Tank Seam.

MR. SMITH: That's right.

MR. LAURISKI: Your petition for review has not requested a review of the permit for mining in the Blind Canyon Seam within the permit boundaries. Now, to the extent that mining the Tank Seam impacts the hydrology of the aquifer, Big Bear and Birch Springs, I guess that's where I seem to be focused, and perhaps I'm -- perhaps I'm wrong. But when I look at your petition for review, it seems to go very directly toward the significant revision of the permit which is very narrowly focused to the Tank Seam. However does this get us to that point, and explain to me if you would, how we can broaden our look at the permit that was granted for the Blind Canyon Seam in 1991, that's now a final order of this Board, and now go back and review that?

MR. SMITH: Well, I think you need to do that for several reasons. First --

MR. LAURISKI: Tell me how we can do that legally.

MR. SMITH: And I -- let me attempt to do that, Mr. Chairman.

First, as you pointed out, a permit was issued in 1991. From the very own records of Co-op, that are here in evidence, they have asked to be put in evidence today, it shows since 1991, there has been a dramatic and significant increase in water discharge from that mine.

MR. HANSEN: Objection.

MR. LAURISKI: I've asked a question.

MR. SMITH: When we went through this --

MR. LAURISKI: I'm not a witness at this point.

MR. SMITH: Yeah, and that's in the PHC that talks about where it went from a fairly dry mine, to an extremely wet mine, to now where it's discharging, even under the latest figures, in excess of 100 gallons a minute. We think that's an extremely great amount of water because it's three times what Birch Spring is producing, and what is being produced from Big Bear Spring.

And so, that's one thing that's different. I don't think that that's -- that was ever determined. That's new information that happened since 1991, and to claim that was determined in 1991, this is information that's developed since then, and is in their new data, that's before this body at this time and is the scope of review. I think that's the question.

You are saying how can we have the broader scope of review? Do we have the power to look at anything more than just the Blind Canyon, the mining up in Blind

Canyon? This is all being mined through the same mine. It's all the same water discharge that's happening now, is going to continue to happen as this mine operates. The only thing that's going to stop this is when this mine quits operating. That's the only thing that's going to cause this interruption.

And it says, as I pointed out in the regulations that this Board operates under, for review of a permit, granting of a permit or approval, permit for Co-Op Mining reclamation, operations permit change, renewal, or transfer or assignment of sale of permit rights, the applicant, permittee or any person with an interest which is or may be adversely affected may request a hearing.

We're going to be adversely affected if you grant this permit and allow this mine to keep operating for another six years.

MR. LAURISKI: And that's I guess my question. How do you say you're going to be affected by mining in a Tank Seam? That's what I'm driving toward. Where does the significant revision for mining the Tank Seam impact the water user?

MR. SMITH: It impacts in several ways. One is --

MR. LAURISKI: I'm going to do this. Without having to go into all your closing arguments, I think that's where we're having some real difficulty as Board members, and we want to provide the opportunity for everybody to be heard. But we see the scope, I guess, and we've had discussions that our scope seems to be directed toward a significant revision. The petitioners in this case haven't asked us to look at the permit that was granted in 1991, toward the Blind Canyon Seam. The petitioners have asked us to review the significant revision for the Blind Canyon Seam. The mining of that tank canyon seam impacts what's happening in Blind Canyon seam and the aquifer, and we understand that. My question is how do we get there?

MR. SMITH: I think we get there through several things. One is anyone who is adversely impacted, and that's us, we believe.

MR. LAURISKI: I understand that.

MR. SMITH: The mine will continue to operate, continue to operate the same, and discharge water in the same method as it's discharging water now through extending the workings into the Tank Seam. We believe there will be water found in the Tank Seam. But whether or not water's found in the Tank Seam, we don't think the Board can take that narrow of a view of this situation, because it's not only whether you may be impacted in the future. And there's important, although somewhat subtle language, that says anyone who is or may be adversely affected may request a hearing. It doesn't say only those persons who may be, only those persons who may be adversely affected by what the future activities are. But if you are being adversely affected you have a right to request a hearing and that's the scope of review.

And I spent several hours carefully looking through the regulations that govern this Board and govern the Division, and found nowhere in those regulations, and if I'm wrong I'm sure someone here will correct me, nowhere it says if you look at a significant revision you only look at those aspects of the revision that are new. You look at also the aspects of how the mine will operate under that significant revision.

This is going to extend the life of this mine, this is going to continue to have water move out of the mine, and be pumped out as it has been pumped out. And we think that's within the purview of this Board because we are saying we are being adversely affected, and that's within the scope of this regulation when this came up for this significant revision.

MR. LAURISKI: I'm with you, thank you very much. Go ahead and finish now.

BY MR. SMITH:

Q. Mr. White, can you, in looking at this, I think this is exhibit --

MR. LAURISKI: This may be a good -- I hate to keep doing this to you Mr. Smith, but I extended your discussion beyond the five minutes I was hoping you were gonna finish. We'll take a break. There's a few of us that need to stand up and stretch. We'll reconvene at 3:00.

(Whereupon a recess was taken.)

MR. LAURISKI: All right. We'll go back on the record. We're going to go ahead and let you proceed, and we've noted your comments relative to what this Board should be considering, and it will consider all the evidence when we recess to consider this case. So, if you want to go ahead Mr. Smith, you may proceed.

MR. SMITH: Thank you, Mr. Chairman.

Q. Mr. White, I'll show you what's been marked I think as Exhibit 15. You've seen this before. You were here?

A. Yes.

Q. It's a chart of some flows of Birch Spring and Bear -- you can just ignore Little Bear Spring, the one that's marked in red. I just was wondering if you have an explanation for the decline in flows in Birch Spring and Big Bear Spring that occurred over the period of time that's shown in Exhibit 15?

MR. MITCHELL: Your question is looking only at that chart. Does he have an explanation for what's going on?

MR. SMITH: Well, I --

MR. MITCHELL: Or are you asking general knowledge?

MR. SMITH: Based on general knowledge. This is representative of flows, and it shows there's been a decline in flows over the last few years, and we've had testimony as to that before. And my question is just whether he has an explanation, based on his work that he's done for Co-op Mine, as to what may be the cause of the decline in flows in Big Bear and Birch Spring.

A. We evaluated flow data from the Springs and the precipitation data somewhat similar to what you have in that exhibit. And it's my opinion that the flow from the Springs has been influenced by a decrease in precipitation in the area.

Q. I'd like to show you Exhibit 16. It shows the precipitation. This is a shorter period of time, 1989 to 1994, and it shows some spiking in the precipitation, and not the spiking in the Birch Spring. Any explanation or why Birch Spring doesn't seem to be responding to increases to precipitation?

A. Yes. I think the problem -- which exhibit is this?

Q. This is 16.

A. And the other one was 15?

Q. Yes.

A. I think the problem that you have in looking at Exhibit 16 compared to 15, 16 is a presentation of monthly flow data, I believe, and monthly precipitation data it appears, whereas Exhibit 15 is a presentation of annual data. In our valuation of the data, we came to the conclusion that the response time for the springs to respond to a change in precipitation was typically on the order of two or three years.

So to evaluate monthly data, it becomes difficult. You're looking at a data set where the time frame is shorter than what the response time is going to be, so it becomes more instructive to look at things on an annual basis, and see what's happening annually, since that response time tends to be a fair amount slower.

Q. But back to Exhibit 15, which is on an annual basis, which you suggested, looking at Birch Spring which is in the yellow here, there doesn't appear to be any response to any increases in precipitation in Birch Spring at all?

A. Sure, but I think you're looking at a -- the only -- hold that up. When was that increase? Looks like in 1993, from '92 to '93, you had the increase in precipitation, and then you've only got one year of data after that in Birch Spring. Also, one thing you need to recognize in evaluating the data, we have been through a period, as you can see from the precipitation graph, we've been through a period of rather extensive drought for the last several years. Your normal response time also is assuming that you have pretty much an equilibrium of conditions in the hydrologic regime that you're not having to put a lot of that excess water into storage.

Since we've gone through a period of rather prolonged drought, increased precipitation now is that snow melts and as the water percolates into the ground, a lot of that is going to go to satisfying the lack of soil moisture that's in those upper layers. And so at this point a lot of the water that would normally go down and recharge a deep system isn't going to get there because everything above that point is so dry.

But, again, that increase in precipitation at the end, we only have about a year's worth of data after that. And as I indicated earlier, the response time that we had seen before for other springs in the region, were longer than that time frame. We're typically looking at two or three years as opposed to just a one year response time.

Q. But during that same period of time, the water encountered in the mine was increasing, and I assume it's recharged by the same precipitation?

A. Well, again, as was discussed I think in the last hearing, the primary area for recharge is, and as we have talked about somewhat here, the primary area for recharge is, in my opinion, to the north of the permit area a fair ways. And so, yeah, there is recharge that's occurring to the -- from water percolating down through the stratigraphic column. Most of the recharge to the Black Hawk Formation may well be coming from what's percolating down through areas right above it, that's why that water tends to be much older. Recharge to the units of the Star Point Sandstone that are on the east site of the Blind Canyon fault, appears to be coming probably back from that shatter zone where recharge is going to be much more rapid. And so, any time that you've got -- you have recharge from precipitation, this is the response that you see out at the spring or response that you see in the water levels in the monitoring wells, is just a pressure response.

The two year or three year time frame doesn't mean that two years after the water hits the water table, that drop of water is now discharging at the spring, it means it takes that two or three years for that pressure response to make its way through the water table. And if you've got a condition of prolonged drought where the pressure in the system is significantly lower, then it's going to take longer to build that back up until you can see that response going through, because so much of that water goes to recharging the storage conditions in the aquifer.

MR. SMITH: That's all the questions I have.

MR. LAURISKI: Mr. Appel?

MR. APPEL: Thank you.

Q. You mentioned that you'd had additional experience in this particular area, with respect to the hydrogeologic investigations. Have you worked in any other mines?

A. Yes.

Q. What were they?

A. I've worked at Genwal, coal mining operations at the U.S. Fuel Operations, at Utah Fuel Company Skyline Mine, Suffco (sic) operations down in Salina over at Andalex, at the Horse Canyon operations in Sunnyside, Soldier Creek Coal Company operations in -- up Soldier creek Canyon. Those are what come to mind.

Q. And that was hydrogeologic work?

A. Yes. The work that I've done included both groundwater investigations as well as design of surface run off and sediment chrome faults, surface water issues.

Q. Is it fair to say you have had a chance to rely upon much of the literature that has been mentioned in this hearing?

A. Yes, I think that's fair.

Q. Including Mr. Lines?

A. Yes.

Q. Since water is one of your main subjects, maybe you can answer this question for me. Do you know what water they're going to use, or actually how much water they're going to use in the mining of the Tank Seam?

A. I would assume that the water use would be somewhat similar in the Tank Seam, compared to what has been used recently in the Blind Canyon Seam. It's, as far as I know, the mining methods are going to be somewhat similar, so I would expect it to be -- the usage to be similar.

Q. How much is that?

A. Currently it's my understanding they're using between 10 and 30 gallons a minute of water in the Blind Canyon Seam.

Q. What's the source of the water they're going to use to mine the Tank Seam?

A. Water that flows into the Blind Canyon Seam, it's my understanding that that water will be utilized for mining up in the Tank Seam.

Q. So they'll pump it up to the Tank Seam?

A. That's my understanding.

Q. So that's an introduction of new water into the Tank Seam?

A. Yeah, probably is.

Q. Do you know if they made any filings with the state engineer's office to change points of diversion?

A. I'm not aware of that.

Q. Do you know where that water is going to go once it's released into the Tank Seam?

A. The water would be used for dust suppression and general uses within the mine. What's -- what little bit accumulates would probably eventually seep back into the ground and make its way vertically downward.

Q. Through the fractures and joints and cracks?

A. Through the formation. I don't know what extent of the fractures and joints is throughout the Tank Seam. But it will make its way down through the formation. What typically happens in the Black Hawk Formation is that water percolates vertically until it hits a less permeable layer, a shale or silt stone in the Black Hawk, and then accumulates on top of that creating your perched layers.

This water would follow that same type of a path, I would assume, and accumulate in perched layers similar to what other water would be expected to do.

Q. In the course of preparing your report, have you specifically dealt with where this water will go?

A. No. I mean we felt like it was our opinion that there would not be -- they're not going to be pumping an excess amount of water in to the mine, they are pumping the amount of water they need to the mine, and they are not going to be pumping an excess that's going to have any place to go. The worse case condition, you could say that all of the water is incorporated in to the coal and gets hauled out of the mine with the coal. And that the net loss of water from the system in the worst case condition is the amount of water that's actually used in the mine, that 10 to 30 gallons a minute.

Q. Well, that's your best case, I think. The worse case is that it's not all absorbed and begins to move down in to the strata, isn't that correct?

A. No, or I wouldn't have said that. The worse case as far as the loss of water, is that it all goes out with the coal and you lose 10 to 30 gallons a minute.

Q. Okay. Maybe we're approaching this from a different angle. My greatest concern -- excuse me?

A. It appears to be so.

Q. You're sense of humor is still intact.

A. It is.

Q. My concern is that the contaminants created by this mining are going to move downward with the water; isn't that a possibility?

A. All things are possible. I believe though, again looking at the current mining operations, looking at the data, the discharge data coming from the mine, the data indicates to me that the mining operation is not adversely impacting in the Blind Canyon Seam. The mining operation is not adversely impacting the quality of the water. Therefore, from that I would conclude that similarly mining in the Tank Seam would not adversely impact the quality of the water since the mining methods are going to be similar.

Q. But it is true that any water that is not absorbed into the coal will migrate downward, it will not be removed from the mine?

A. That's true.

Q. With the coal?

A. That's true.

Q. So any contaminants fixed to that water will move downward also?

A. To the extent that -- to some extent yes, depending on the contaminant. If you're dealing with a -- for instance an oil and grease contaminant, those constituents tend to be absorbed onto the materials, particularly as you go through the fine grain sediments that are typical of the Black Hawk Formation. And so some of those contaminants, if they occur, are going to be absorbed and will never make it down to some greater depth.

Q. But it's fair to say that any time the amount of water exceeds the absorption capacity of the process, that water will be liberated and could flow downward?

A. Yes, that's true.

Q. Okay. Do you know what Co-op does with human waste generated by the miners?

A. I'm not sure.

Q. I want to talk to you a little bit about water interception because the one thing I think we can all tell is water is intercepted. And I've gone through some of your documents, most of your documents, and I want to ask you some questions that I think are conclusions based within that. And believe it or not I'm not trying to trick you, I'm just trying to help the Board and everyone understand the fundamentals of your geologic conclusions here?

A. Okay.

Q. Your drilling has shown three distinct aquifers with individual static water levels within the Star Point Sandstone.

A. That's correct.

Q. They're not all fully saturated, are they?

A. The individual tongues? Is that what you mean?

Q. Yes.

A. Yes, that's correct.

Q. So they're not full?

A. Yes. That's correct.

Q. In layman's terms?

A. Yes.

Q. Are you familiar with drill holes one through three?

A. Yes.

Q. Are you familiar with the length of the core in drill holes one through three?

A. Off the top of my head I can't remember, but as I recall, there are some data that are presented in the various exhibits. But there has been -- I believe one of them, I think it was drill hole one, was continuously cored, and the other drill holes were cored in sections.

Q. I'm not going to ask you any specific questions, just a couple, so if you'd like to refer to the document, that's more than fair because I think it explains itself.

How deep did you drill the holes?

A. That one I can't answer.

Q. Let me ask you an easier question. Did you drill down to the main member of the Mancos Shale in each hole?

A. In each hole we went through -- yes, we encountered what we felt was the terminal Mancos Shale, the primary section of the Mancos Shale based on our review of geologic literature in the area and our review of outcrops, and what we felt the sequence of the sandstone tongues was going to be like within the Star Point Sandstone. We knew there was a reasonable potential for encountering three tongues if they existed if the parts were there. And so we felt like the portion of the Mancos Shale that we bottomed each hole in, we felt like that was the main body of the Mancos Shale.

Q. That's important because that's really the ultimate contact for water, water will --

A. Yes, that's going to be the basement, if you will.

Q. Okay. That's what I was after. Now, you may have drilled your holes that deeply, but in fact you don't monitor all the way down to the Mancos Shale, do you?

A. The monitoring wells were not completed in each case down there. What we did was as the holes were drilled, we would get in to a zone where we were encountering one of those shale lenses, and we then tested each tongue of the Star Point as we drove down, so we could gather data from each tongue separately, where we could gather water level data, water quality data, and also determine what the hydrologic conditions of that tongue were.

Then we would advance the hole down in to the next tongue and do the same thing. Once the holes, once we were done with the drilling operation, then each hole was completed just in one of those tongues. Rather than completing each hole in all three tongues, we chose one tongue to complete them in, but gathered data during drilling from each tongue.

Q. So, each drill hole monitors one section of the Star Point?

A. That's correct.

Q. Okay. How far apart are these drill holes, generally speaking?

A. There's a map in Exhibit D, Figure 3-1 that shows the locations of the drill holes. It would appear that drill hole 1 A and 3 are about a thousand feet apart, and 1 A and 2, are about 2000 feet apart.

Q. So you have one hole to determine how the hydraulics within the Panther Tongue perform?

A. No. Again, we tested, as we drilled down, we tested each zone individually in each hole. So, out of each hole we gathered data from all three tongues. We gathered water level data, water quality data and aquifer characteristics data. Then, when that data gathering process was finished, we completed each hole of the monitoring well in only one tongue.

Q. That's what I'm saying. While you did achieve one time results --

A. Yes.

Q. -- in each hole, your continuous monitoring is only one hole in each of the three subsections of the Star Point Sandstone?

A. It was pointed out to me in the -- during the recess that I made a mistake in my earlier testimony, that in fact all of those drill holes are completed in the, I believe it's the Spring Canyon member. They are completed in the shallowest member of the Star Point Sandstone. So we have the three, the object being to monitor groundwater conditions in the aquifer that immediately underlies the coal seam that's being mined, and that was the upper most aquifer that we encountered. So in each of those the monitoring well portion of the hole was completed in that upper most aquifer.

Q. In fairness, though, one hole in the lower members isn't telling us very much about how that water is moving within the entire, for instance, Panther Tongue, is it?

A. In fairness that's not what occurred. Again --

Q. I'm sorry?

A. That's not what exists. Again, and undoubtedly the problem is that I hadn't understood when I answered Mr. Smith's question earlier. Earlier I'd indicated that each hole was completed in a different -- the monitoring well was completed in a different tongue. During the break, I was reminded that that was not the case, that each hole in fact was completed in the Spring Canyon member of the Star Point Sandstone.

Q. Which is the upper most?

A. The upper most. So we have three holes completed in the same member, as opposed to being completed one hole in each member. And again, during drilling, we obtained data from each hole in each member, so we have, out of the three tongues, we have three data points from each hole. And then in the end as the monitoring wells were completed, those were all completed in the same Spring Canyon member so the long term data will be obtained from the zone that immediately underlies the mine workings. The idea being that that's going to be the aquifer that is affected first by mining operations if there is any impact, so that's the one you want to monitor.

Q. Okay. That tells us a little bit about your methodology, but the conclusion is still correct, you have one monitoring well in the Storrs --

A. No, again --

Q. Not the spring, the Storrs?

A. We have three monitoring wells in the Spring Canyon Tongue.

Q. But that's the upper most?

A. Yes.

Q. Of the three, I said the Storrs?

A. We have none in the Storrs, and none in the Panther.

Q. Thank you very much. So really we don't know how the water is moving?

A. Yes, we do.

Q. On a continuous basis?

A. As I indicated earlier --
Q. You have to let me finish my question.
MR. LAURISKI: Let him finish the question.
BY MR. APPEL:
Q. Do you have any continuous monitoring in the Storrs --
A. No.
Q. -- Formation?
A. No.
Q. Do you have any intentions to monitor in the Panther Tongue?
A. No.
Q. Thank you.
A. You're welcome.
Q. Would you agree with me, that the Birch and Bear Springs issue, essentially from the contact between the Mancos Shale and the Panther Tongue are the Star Point Formation?
A. That's correct.
Q. And they're the only springs of note that issue from that contact in the vicinity of this particular mine?
A. That's correct.
Q. Let me ask you this. Have you investigated the cliff face in Bear Canyon?

A. I have not personally.

Q. Have you read any reports of the cliff face where the Storrs Formation and Spring Canyon Formation, as they exit into that canyon?

A. I can remember there being some discussions in the documents, some of the documents concerning that cliff face above the -- above one of the springs. I can't recall if it's Birch Spring or Big Bear, and I remember the discussions at the hearing, the last hearing, where there were discussions of some of the cliff faces.

Q. But there are no springs that issue in the cliff face in Bear Canyon from the Storrs Formation. It's easier for her if you don't talk at the same time.

A. Excuse me.

Q. The Storrs Formation or the Spring Canyon Formation of the Star Point?

A. As I understand there is seeping that occurs.

Q. I said springs.

A. It's a matter of semantics.

Q. It's not a matter of semantics.

A. Would you define the volume then.

Q. Something of the level of flow of Birch or Bear Canyon.

A. That's correct, there are no springs of the level of Birch Spring that issue from the Storrs or the Spring Canyon member.

Q. Thank you. I think it would be fair to summarize your testimony, and I know you will tell me if this isn't fair, or correct me one way or the other, that the entire area suffers from significant fracturing and jointing?

MR. HANSEN: Objection, ambiguous as to what significant means. Needs clarification.

MR. LAURISKI: You can answer the question Mr. White.

THE WITNESS: There is a lot of jointing and fracturing in the area, yes.

BY MR. APPEL:

Q. And you've testified that because of that, water moves downward through these various layers?

A. I don't believe I testified that it moved downward, but I did say that it does at least move laterally.

Q. I think you also testified it moved vertically?

A. That's back up in the shatter zone, yes.

Q. Will it also move vertically in the area above the Blind Canyon Seam and the Tank Seam?

A. Any place there is a -- that there's a fracture encountered, if the formation at that point is saturated, water will move vertically through that fracture. Assuming that the fracture has a significant aperture on it, you can get water into it, that it's not sealed tight as sometimes occurs as you get in to the bedanetic (sic) mudstones and shales that occur in the Black Hawk Formation as well as in the tongues of the Mancos Shale.

But typically you're correct, that the fracture tends to be the point of least resistance so it's easier for water to flow through fractures as opposed to unfractured bedrock.

Q. On that basis could a drop of water on the top go down, move through the entire stratigraphy to the Mancos Shale?

A. If you had a fracture that was that continuous, that assumption was correct, then yes, that would occur. I know of nothing that would indicate that that assumption is correct though.

Q. Well, the entire area is regionally fractured, isn't it?

A. Yes. And I believe back up in that shattered zone you may have that sort of a condition. But to infer that condition occurs through the Black Hawk Formation in the area of the permit area, I think that's not a correct -- I don't think that's a safe assumption to make.

Q. Well, isn't it equally likely?

A. No, I see nothing in the geologic data that suggests you have fractures that are vertically extensive in the area of the permit area that would go from the mountain top down into the Blind Canyon Seam. That should have a single fracture that would do that.

Q. Okay. That's our problem because I'm not asking for a single fracture, but because they are connected as you've testified before, many of these are interconnected, are they not?

A. Yes.

Q. So it may move vertically some point and then laterally?

A. That was my misunderstanding, I'm sorry. Yes, there are. Any place there are fractures you get vertical flow. The amount of that flow is going to be a function, of course, of the amount of water that's supplied to the fracture in the area that overlies the permit area. The bulk of the land surface above the permit area is rather steep, it's predominately outcrop in that area, the Black Hawk Formation, and it's very difficult for water, for any significant amount of water to percolate down through that type of a situation where you have a steep area that experiences rapid run off.

No area really for the water to pond and to percolate down through. Most of the recharge in the area typically occurs back in the -- along the Wasatch plateau to the north of the permit area where you have the North Horn Formation that does outcrop in an area that's remote from the permit area.

Q. Okay. Another hopefully true or false question. As mining has moved back into the mountain, water has been encountered in increasing volumes, true?

A. Yes, that's true.

Q. Now, this is where I think we differ, or you and Mr. Montgomery would differ. Your basic assumption is that is because you are encountering perched aquifers as you move back into the mountain, correct?

A. Yes, that's correct.

Q. His assumption is that you are mining in to the potentiometric surface which would be the regional aquifer; correct?

A. That's my understanding of what his understanding is. Yes.

Q. But that's really where we part company, isn't that right?

A. It would appear if that's your opinion, then yes, that is different than my opinion.

Q. Would you like to translate that into English?

You don't need to answer that one.

It appears the reason I'm saying that is it appears we have essentially the same facts before us, but reaching diametrically different conclusions; is that right?

A. I would definitely say the same facts were available to both of us. You know, everything that we've got here, that our exhibits are basically in the public record, so that's probably a safe assumption.

Q. But your theory requires that you intercept perched aquifers all the way back through the mining rather than the potentiometric surface; is that correct?

A. That's correct.

Q. If it was the potentiometric surface you're intercepting, then you could be affecting the flow of these two springs, correct?

A. I don't think so. Again, because the Panther Tongue which is the source of the water to both Birch Spring and Big Bear Spring is hydrologically disconnected from the Storrs Tongue and the Spring Canyon Tongue. If we're in a situation -- if we didn't have this separation of aquifers within the Star Point Sandstone, then that assumption might be correct. If we had one continuous Star Point aquifer down there, and we're mining into the water table that was feeding that aquifer, then yes. Anything we encountered would be diverted away from those springs.

However, the data we obtained during the drilling of the holes from the Blind Canyon Seam down in to the Star Point Sandstone indicated that those three aquifers, those three tongues were not hydrologically connected, so even if we were mining in to a water table, it would be, which I don't think we are, but if that was occurring, it would be a water table associated with the Spring Canyon Tongue, not a water table associated with the Panther Tongue. And so we would not be moving water out of the source of recharge to Big Bear Spring and Birch Spring.

Q. But you previously testified that in this smaller region called subregion, we have coextensive fractures, joints, and certainly you've mentioned some very large faults. And it appears to me that these are connected. And the reason I say that also, is because you previously testified that these shale tongues, the Mancos Shale tongues are discontinuous in certain areas. I think the word you used was they were not aerially that broad, and that they would thin, and then become thicker and in some places become --

MR. HANSEN: I haven't heard a question in this and I ask he confine his closing argument to closing argument. If he has a question, let's get to the question.

MR. LAURISKI: Well, I think that's where he was headed. Go ahead.

BY MR. APPEL:

Q. I prefaced it, it was a question -- it seems every time I ask a hard question I get an objection.

Do you remember that question per chance?

MR. LAURISKI: Why don't you restate it.

BY MR. APPEL:

Q. I'll try to break it up, that way we should be able to deal with Mr. Hansen's objections.

Didn't you testify that these Mancos Shale tongues which interlineate the Star Point Sandstone are laterally in some cases discontinuous?

A. Yes, that's correct.

Q. So they don't exist in certain areas?

A. That's correct.

Q. Okay. In those areas water would pass freely if there were joints and fractures, correct?

A. Through the Star Point, that's correct.

Q. That's correct. And in fact, when these sandstones fracture, if it's a thin layer of Mancos Shale, that will fracture too, won't it?

A. At some point, you're correct, that the Mancos thins out to the point it become hydraulically insignificant.

Q. Okay. So water can pass through the Star Point members, through fractures and joints?

A. In some locations, yes, but not beneath the permit area. The data we have beneath the permit area indicate that at least in that area, these tongues seem to be laterally continuous.

Q. And that data is based upon three drill holes?

A. That's correct.

Q. A thousand feet apart?

A. 3,000.

Q. 3,000?

A. I indicated two of them were a thousand feet apart and two of them were 2000 feet apart. And the distance from one to the other is three.

Q. Operating as a scientist, would you be more comfortable making that conclusion if you had five or six more drill holes that showed you that?

A. Of course, yes.

Q. Okay.

A. One never has enough information.

Q. I recognize that. Do you think that the mining of the Blind Canyon Seam has changed the underground hydrology of the stratigraphic sections?

A. I don't believe that mine in the Blind Canyon Seam has impacted the hydrologic conditions in the members of the Star Point Sandstone that feed the Bear Canyon Spring and Birch Spring. I do believe mining has encountered perched groundwater in the Black Hawk Formation so there has been some water in the Black Hawk that's been encountered, but I don't think that is water that was or would have normally flowed into either Big Bear Spring or Birch Spring.

Q. Well, and you recognize I don't agree with that conclusion, but in fact you are intercepting and taking it out in an entirely different place than would have occurred before mining, isn't that true?

A. Well you're taking it out the --

Q. Mine portal?

A. The portal. That water that would have discharged out of the -- out of the Black Hawk Formation would still have exited somewhere on the face of the mountain. It's just that what you're doing now is pumping it out the portal instead of allowing it to reach the face of the mountain alone.

Q. That's an awful lot of water isn't it?

A. That's a relative term.

Q. Of course it is, it's relative to the size of the springs. Were you here during some of the historical testimony at this hearing?

A. Yes.

Q. Recognize that those people testified they never saw springs coming out of the cliff in these formations?

A. Yes, I remember that.

Q. And that the two springs, Birch and Big Bear are two large springs?

A. Yes.

Q. I want to be careful with the scale with you because it's very important.

A. I remember that. Well, now, would you go back through that. Didn't you say that I do remember that people testified that they saw seepage out of the face of the mountain?

Q. Your people testified to that.

A. No, I think your people did too. As I remember, there was some people from the water companies who testified of ice that had formed on the face of the mountain, and other conditions.

Q. So you know, that's the ice that occurred once Co-op dumped water into that section of the mine.

MR. HANSEN: Objection.

MR. APPEL: That's how that testimony came in.

THE WITNESS: I don't recall that part.

MR. LAURISKI: I'll sustain that one.

MR. APPEL: I understand that took -- it's true though.

Q. All supposed levity aside, where did the water that's coming out the portal go before there was mining?

A. Any water that's encountered in the underground workings would have naturally either discharged to the surface, or would have remained. Some of that is going to remain in place as a result of just long term storage of that water, water that is eventually going to discharge.

It's my opinion, that based on the work that I have done in the region, and evaluation of discharges of water from the Black Hawk Formation, and evaluation of other mining operations, it's my opinion, that flow in the Black Hawk Formation sandstone predominately controlled by the presence of the confining perching layers that are present throughout the Black Hawk, that that basically forces the water to flow laterally to the extent of that perching layer. And you get, as a result, seepage that occurs at the mountain face. You get seepage that's going to occur out of a sandstone lens, typically from the Black Hawk Formation where it overlies some perching layer.

That seepage can occur over such a broad area it becomes very difficult to define it as a spring, and in fact in most cases you can't define it as a spring. Specifically if you say a spring has to have at least 20 to 30 gallons a minute of flow.

Q. I'll stop you at some point because you're not really answering my question --

A. Okay.

Q. -- at this point. The two main exits for water historically, as far as you're aware from that cliff face, or those cliff faces, is the Birch Spring and Big Bear Spring without this portal in place, correct?

A. Those are the main Springs in the area. Those are not the only areas of seepage, but those are the main springs.

Q. Okay. Thank you. You gave us some testimony concerning the effect of the Blind Canyon fault. Are you aware of the existence of geologic mapping of a subfault or branch fault of the Blind Canyon fault that intersects Birch Spring?

A. I would have to look at the map.

Q. I would think that would be fairly important if it's connected to a major fault you are saying is blocking the transmission of water.

A. Yes, and I would be glad to look at the map, if you'd like to.

Q. Okay. Presuming the existence of such a branch fault, would not the water intercepted by the main fault move down?

A. I can't say that. I'd be glad to look at the map and we could evaluate that. That's -- as I indicated earlier, all things are possible and I believe that's a possibility.

Q. But your testimony was that Birch Spring couldn't be affected because it was 800 feet away from the Blind Canyon fault?

A. And concurrent with that, my testimony was the Blind Canyon fault itself, regardless of whether it's acting as a conduit or as a barrier, would tend to divert water away from Birch Spring as opposed to toward it. I'm not aware of that splinter fault that you're discussing, so I'd have to look at the map before I can pursue that.

Q. No one brought that to your attention during the course of your review?

A. I'm afraid not.

Q. Okay. In any event, the Blind Canyon fault wouldn't have the same impact on Big Bear Spring, would it?

A. No, that's correct.

Q. And directly up gradient from the Big Bear Spring is the Co-op Mine, correct?

A. That's correct.

Q. You don't have the same argument concerning the effect of a fault with respect to Big Bear Spring, do you?

A. That's correct.

Q. So anything that happens above, in that mine above could conceivably affect Big Bear Spring?

A. That's incorrect.

Q. Why is that?

A. I've stated my opinion that I do not believe that the workings, that the mine workings are hydraulically connected to the Panther Canyon Tongue of the -- to the Panther Tongue of the Star Point Sandstone.

Q. And that's because of your assumption that those interfingerings of Mancos Shale would interfere with that?

A. That goes into that conclusion, as well as the water level data which were collected from the holes that were drilled into the Panther Tongue, as also including the water quality data that were collected from the Panther Tongue from the overlying tongues.

Q. Your three drill holes?

A. My three drill holes as well as the Tritium data which reflected -- which indicate that the water encountered in the mine is of a significantly older age than the water that's being discharged in to Big Bear Spring.

Q. Okay.

MR. APPEL: I think that's all I have.

MR. LAURISKI: Thank you. Any redirect, or I guess Mr. Mitchell?

MR. MITCHELL: No questions.

MR. LAURISKI: Anything on redirect?

MR. HANSEN: No.

MR. LAURISKI: Thank you Mr. White. Any further witnesses, Mr. Hansen?

MR. HANSEN: Co-op mine has no further witnesses.

MR. LAURISKI: Mr. Mitchell?

MR. MITCHELL: I have one.

THOMAS MUNSON

was duly sworn, was examined and testified as follows:

BY MR. MITCHELL:

Q. Would you please state your name and working address for the record?

A. Tom Munson, I work at the Division of Oil, Gas and Mining, 3 Triad Center.

Q. Who are you employed by?

A. State of Utah Department of Natural Resources.

Q. Working for?

A. Working for the Division of Oil, Gas and Mining.

Q. And what are you employed as?

A. My official title is reclamation specialist three, but I'm a hydrologist. That's a general term,, reclamation specialist in that category and I am a hydrologist.

Q. Have you ever heard of -- have you been here for this whole hearing?

A. Yes, I have.

Q. Have you ever heard of the Co-op mine and Bear Canyon mine?

A. Yes, I have.

Q. Are you familiar with a Division finding regarding the Tank Seam significant amendment?

A. Yes, I am.

Q. Are you familiar with the section of the Division's findings dealing with water?

A. Yes, I am.

Q. Why are you familiar with it?

A. I made that finding.

Q. And in what capacity did you make that finding?
A. As a hydrologist reviewing the Tank Seam amendment, I was responsible for making the finding of no significant impact to the hydrologic balance.
Q. Tell the Board what your educational background is?
A. My educational background, I have an associate's of arts and science from Paul Smith's college in Up State New York and environmental technology. Graduated 1975. I graduated from Utah State University with a degree in water shed science in 1979. I also have worked two years for the Forest Service as a hydrologic technician; for Dames and Moore Environmental Consultants in Florida. I worked from 1980 through 1982 when I became employed at the Division as a hydrologist in 1982, and have worked here since 1982.
Q. Have you always worked in the capacity of a hydrologist?
A. Yes, I have.
Q. Have you ever reviewed mine plans, requests for permits, revisions, amendments to permits?
A. Yes, I have.
Q. How many would you guess, round numbers?
A. I would have to put it in the hundreds.

Q. The step by which -- steps by which this process takes place, in this case, my understanding is this was called a significant amendment; is that correct? Revision, excuse me.

A. That's correct.

Q. And when there's a significant revision, does that mean there's already a permit in place to do something?

A. Yes, that's correct.

Q. What is it that's being revised then?

A. It's a revision. A significant revision is I believe, when you impact -- that's not just a minor, there's a minor amendment of the significant revision. As far as making that determination, it's based on the amount of, like in this particular situation, they're mining a whole new seam so it was a significant revision to the existing Bear Canyon permit, which already has permitted the Blind Canyon Seam and the Hiawatha Seam or mine.

Q. Prior to the issuance of the original permit for the Blind Canyon Seam, was there any hydrological data submitted for the issuance of that permit?

A. Yes.

Q. And is that what's called a PHC probable hydrological consequence information?

A. Correct.

Q. And before you make a finding granting them a permit, does the Division have an obligation to do anything with that document?

A. It has an obligation to review it to make sure that all the baseline data is collected in a manner which is appropriate to make what we consider cumulative hydrologic impact assessment.

Q. That's called a CHIA, right?

A. Yes.

Q. Now the CHIA, that's something you're required by law to do before you can issue a permit; is that right?

A. Yes, that's correct.

Q. And it differs from a PHC how?

A. A cumulative hydrologic impact assessment or CHIA is a analysis of the data presented in a PHC.

Q. And does it take in to account other information beyond what was submitted by the operators sometimes?

A. It takes in to consider all the data available do the Division from any source.

Q. Would that include from other mines, mining in the same region and area?

A. That would take in to consideration mines, federal, state agencies, any source of information that we could use.

Q. Prior to the request for the significant revision to mine the Tank Seam, had the Division reached -- issued a CHIA with regard to mining of the Blind Canyon Seam?

A. Yes, they had.

Q. And what was the result of that?

A. The result of that, there was a finding of no significant impact to the hydrologic balance outside the permit area.

Q. Now, have you ever been to any previous hearings where the water users that are protesting this revision today, have raised issues concerning the mining in the Blind Canyon Seam?

A. Yes, I have.

Q. And as a result of that, have you ever requested additional information of this operator?

A. Yes, I have.

Q. And what was the additional, what additional things have you requested?

A. Information that we requested was the three drill holes into the Star Point Sandstone, in addition to increased monitoring requirements of Big Bear and Birch Springs.

Q. In other words has it been brought to your attention previously?

A. Yes.

Q. That there was a concern on the part of the water users, that mining in the Blind Canyon Seam was having an affect on these springs; is that right?

A. Yes, that's correct.

Q. And you asked them to do -- you asked the mine to do additional things to attempt to determine whether or not that was a possibility?

A. Yes.

Q. Did you, prior to receiving the request for significant revision, did you receive this additional information from these three drill holes?

A. Yes, we have.

Q. Okay. Have you received any information either from the operator or from the water users, that changed your opinion concerning the underlying permit request for a significant revision, concerning the cumulative hydrological impact assessment that you reached when you issued the permit?

A. No, I haven't.

Q. When the request for a significant revision to mine the Tank Seam arrived, did you request information above and beyond, or in any way shape the nature of the information that was created for that revision?

A. No, I hadn't, no I didn't.

Q. So, the information that was received for the significant revision was not an out growth of anything that had gone before, it was simply in terms of what you had requested of the mine previously. This is simply the information that was provided to you; is that right?

A. Yes, this is correct.

Q. Prior to the time, prior to the hearing as you say you've been at this hearing, where you've been for both days of the hearing, were you familiar with the petitioner's expert's theory of the hydrology as it relates to the mine and to the two springs?

A. Yes, I am.

Q. Have you heard anything today and the previous day that changes your understanding of the plaintiff's or the petitioner's expert's theory of what's going on?

A. No, I haven't.

Q. At the time you made the finding to, and made the CHIA finding that the requirements were met and there would be no interference, that they met the requirements of the rules regarding the collection of base ground and water surface data -- sorry, I just did a brain dump. Let me start over.

At the time you made this finding -- no idea where I was going with that question. Just a minute. Could you read back the last question?

(Whereupon the requested portion was read.).

BY MR. MITCHELL:

Q. Do you understand the water users to have a different theory of the hydrology of the area concerning the springs in the mine from that of the mine, the --

A. Yes, I do.

Q. Do you view, in reaching your findings that they have met the requirements for the collection of data and the permit should be issued, does that necessarily mean that you have adopted one theory over the other as being more sound?

A. I would say that's correct.

Q. What is the basis for you having adopted the mine's data and conclusions over that of the conclusions of the water users?

A. Because the mine collected site specific data, specific to that area where the water users' information is more general in scope.

Q. Have you heard or reviewed any evidence specific to the area concerning the mine and the two springs that in any way causes you to question, or doubt the conclusions you've reached in your findings?

A. No, I didn't.

Q. I have no further questions.

MR. LAURISKI: Mr. Hansen?

EXAMINATION

BY MR. HANSEN:

Q. I show you what Co-op mine has marked as Exhibit A. Have you ever seen this document before?

A. Yes, I have.

Q. Can you tell us what it is?

A. It's the Tank Seam road revision.

Q. Did you have any input into the preparation of this document?

A. Not into the preparation of the document, but I reviewed the document.

Q. The first numbered line of this document, under the heading?

A. I'm sorry, maybe I'm thinking this is -- this is the Division's significant permit revision approval.

Q. Okay.

A. So if this is our document yes, I did. This is what we -- I'm just not familiar with the form, but yes, I did.

Q. Okay.

A. I would have made those findings.

Q. Numbered paragraph one says, the application is complete and accurate and the applicant has complied with all the requirements of the state program, and then it has handwritten in "yes". To the best of your knowledge, is that true?

A. Yes, that's true.

Q. Section four states, "The Division has made an assessment of the probable cumulative impacts of all anticipated coal mine and reclamation operations on the hydrologic balance in the cumulative impact area, and has determined that the proposed operation has been designed to prevent material damage to the hydrologic balance outside the permit area", followed by a handwritten notation, "yes". To the best of your knowledge is that a correct statement?

A. Yes.

Q. I offer Exhibit A into evidence.

MR. LAURISKI: Mr. Smith?

MR. SMITH: No objection.

MR. APPEL: No objection.

MR. HANSEN: No further questions.

MR. LAURISKI: Thank you, that will be entered. Thank you. Mr. Smith?

EXAMINATION

BY MR. SMITH:

Q. Mr. Munson, I want to ask you some questions, make some statement and ask if you agree or disagree with my statements.

The recharge area for both the water found in the mine and the water for Big Bear and Birch Spring is the Gentry Mountain area?

A. Agree.

Q. Water moves downward and southward through the North Horn Formation, Price River Formation, Castlegate Formation, into the Black Hawk Formation which is where the mine is and the Star Point Sandstone Formation where the springs are, agree or disagree with that?

A. Agree.

Q. Faults and fractures are principal conveyances of the movement of water downward?

A. Agree.

Q. The water that comes out of the Big Bear and Birch Spring has moved through the Black Hawk Formation?

A. Disagree.

Q. Okay. Tell me why you disagree with that?

A. Basically all the testimony that Mr. White gave previously, I agree with. I agree with the fact that Big Bear and Birch Springs are hydrologically disconnected from the mine, and any sort of water that's contained in the Black Hawk Formation is typically perched, and as such is old water, connate water, found in discontinuous sandstone channels that tend to have been formed in the swamps of the Black Hawk when the Black Hawk was being formed. That's very typical throughout the whole mining region, find it in almost every mine.

Q. I'm confused a little bit, I guess. So you're saying the water that comes out of the Big Bear and Birch Spring as never moved through the Black Hawk Formation?

A. No, I --

MR. HANSEN: Are we talking about generally through the entire area or within the permit area?

MR. LAURISKI: I don't think he defined one way or the other. He asked a question whether or not the water moved through the Black Hawk Formation.

MR. HANSEN: I think the question is meaningless unless it's narrowed.

MR. LAURISKI: I'll let the question be answered.

THE WITNESS: That would be an accurate statement, if you considered the fact that that's a very general question, and water could have moved through the Black Hawk Formation to get to Big Bear and Birch Springs.

BY MR. SMITH:

Q. I'm confused as to why you're hesitant. Obviously the water started out above all these formations, snow and rain, onto the Gentry Mountain

A. In relationship to the impacts from the mine on that, yes.

Q. How is Co-op going to protect the quantity and quality of these sources after the mine closes?

A. How? Specifically?

Q. Yes.

A. We haven't made a determination they are going to impact them.

Q. When will you make that determination?

A. We already did. We made a determination that they were not going to impact the water sources, therefore protection is, to say, synonymous with protection in my view.

Q. Okay. How long have you been working on the Co-op mine?

A. One continuous, adding up all the blocks of time that I have or have not?

Q. No, how many years have you been?

A. At the Division and familiar with the Bear Canyon mine?

Q. That's a good question.

A. I started with the Division in 1982. I believe I've been familiar with it for 12 years.

Q. Have you had any problems with compliance with them in the past?

A. In relationship to what?

Q. Anything.

A. Me, personally?

Q. The Division.

MR. MITCHELL: If you know the answer.

THE WITNESS: Yes.

BY MR. APPEL:

Q. Any significant problems with compliance in comparison to other coal mines in the area?

A. I couldn't answer that question.

Q. How many violations have they had roughly?

MR. HANSEN: Objection, grounds of relevance.

MR. LAURISKI: Tend to agree Mr. Appel, I'm not sure the point of past history or what the history has to do with respect to whether or not this revision is appropriate.

MR. APPEL: Well, if you'd like me to argue it, I can briefly. It goes along with Mr. Smith's suggestion, you look at a larger ballgame here, and their past track record with respect to compliance with Division requirements certainly is important. When you have the lives and livelihoods of people at stake, it's not gonna take too many mistakes to affect these people. So if there's a clean mine, it helps them. If it's one that's less than that or there's problems, I think it's important for that to weigh into the Board's purview.

MR. LAURISKI: We're talking about violations on the surface versus underground to begin with. If you're wanting to limit that question to any issues relative to the water, hydrologic balance, I think it would be appropriate. But if we're talking about whether or not they were in violation for not having a top soil pile identified or something like that, I don't consider that to be relevant to this issue.

MR. HANSEN: I also object, this is far exceeding the scope of direct.

MR. APPEL: I think it's already in evidence, I'll withdraw that particular question.

MR. LAURISKI: Thank you.

MR. APPEL: Take me a moment. Could I direct your attention quickly to page 4, table 4.1 in Exhibit C, Mr. Munson. It's entitled the Summary of Potential Impacts and Mitigations.

A. What's the page?

Q. 4-2. Appendix 7 J. Tell me if you can't find it.

A. I found it.

Q. What does it take to become a mitigation measure for the purposes of this table?

A. This is what Earth Fax put together as a table. This wasn't based on any criteria the Division has per se, other than they presented mitigation measures of their choosing.

Q. Let me direct you to, on that page, groundwater availability, three statements.

A. That's correct.

Q. The mitigation measures monitoring. Is monitoring really a form of mitigation?

A. No, not necessarily. No.

Q. What it would do is provide a signal that mitigation is necessary, correct?

A. That's correct.

Q. So really they haven't answered the question there as to whether or not what mitigation measures would be undertaken as far as availability of groundwater; is that correct?

A. That's correct.

Q. Okay. I don't have any further questions.

MR. LAURISKI: Thank you. Mr. Mitchell?

MR. MITCHELL: No further questions of this witness.

MR. LAURISKI: Mr. Hansen?

MR. HANSEN: No further questions.

MR. SMITH: No.

MR. LAURISKI: Thank you, Mr. Munson. Anything from the Board? Thank you, Mr. Munson.

THE WITNESS: Thank you.

MR. MITCHELL: I'd like to call Daron Haddock.

DARON HADDOCK

was duly sworn, was examined and testified as follows:

BY MR. MITCHELL:

Q. Mr. Haddock, would you say your full name and spell it for the court reporter.

A. Daron Richard Haddock. D-a-r-o-n, R-i-c-h-a-r-d, H-a-d-d-o-c-k.

Q. And what is your position with the Division of Oil, Gas and Mining?

A. I'm a permit supervisor.

Q. Are you essentially Tom Munson's supervisor?

A. For that project, yes.

Q. With regard to the Exhibit A, introduced by Co-op, is that your signature at the bottom?

A. Yes, that is.

Q. And it was you who made the determinations in 1 through 12, as well as any special conditions; is that correct?

MR. LAURISKI: Could you speak up.

BY MR. MITCHELL:

Q. It was you who made the determinations with regard to the listed items 1 through 12; is that correct?

A. Yes.

Q. As well as the special conditions 1, 2 and 3?

A. Yes.

Q. With regard to the materials submitted to the Division for the Tank Seam revision, was that material designed to address only those portions of the plan that would be effected by the revision?

A. I'm not sure I understand.

Q. Is it a completely new application for a permit, or is it an application to revise a permit?

A. It is an application to revise.

Q. Do you judge it on the basis it's sufficient for a completely new permit, or base it on the position it is sufficient --

A. Sufficient to support the revision. We would not go back and necessarily review the entire plan. It would be -- basically we would build on the existing plan, and determine whether or not to approve the plan based on them supplying the necessary information to satisfy the findings that we have to make.

Q. And with regard to the findings for revision, are there requirements for baseline data for the entire permit to be resubmitted, reconstituted, or is the original baseline data that's supporting the permit sufficient to be simply augmented with regard to any revision?

A. Generally in this case we would only look for augmenting the original information. We would not require them to go back and collect all the baseline data that was in the original permit. It would be information relevant to the new permitting action, and that would be augmented to what was already in existence.

Q. As of today, does Co-op mining have an approved revision to allow them to begin mining the Tank Seam?

A. Yes.

Q. Has the Division, to your knowledge, been served with anything which would stop them from having granted that authority?

A. Not that I'm aware of.

MR. MITCHELL: No further questions.

MR. LAURISKI: Mr. Hansen?

BY MR. HANSEN:

Q. Are you familiar with the permit?

A. Yes.

Q. Does the permit itself have baseline data for Big Bear and Birch Springs?

A. Yes.

MR. MITCHELL: Only if you've looked at it and can answer that question with actual knowledge sitting here today.

THE WITNESS: Yes.

MR. HANSEN: No further questions.

MR. LAURISKI: Mr. Smith?

BY MR. SMITH:

Q. Mr. Haddock, look at Exhibit C, please. Is this a completely new hydrologic consequence that you prepared simply for this revision, or is this a revision of the prior PHC that was prepared?

A. I would probably need more time to evaluate that, you know. Just a second.

MR. MITCHELL: Have you actually read that document before, Daron?

THE WITNESS: Parts of it, and I'm not completely familiar with it, no.

MR. APPEL: Mr. Mitchell -- if he wants to interpose an objection, I think that's proper, but this continual coaching of the witness is highly improper.

MR. LAURISKI: I agree.

MR. MITCHELL: Okay. I object, he hasn't established he's ever looked at the document, or is familiar with it.

MR. APPEL: Are you objecting on the grounds of foundation then?

MR. MITCHELL: Foundation.

MR. APPEL: Okay.

MR. LAURISKI: Well, whose question are you objecting to? The question with respect to baseline data was opened by Mr. Hansen.

MR. MITCHELL: Now the question is, what's in this particular document, and I'm saying objection, there's no established -- it hasn't been established he's ever looked at it.

MR. LAURISKI: He just said that he was familiar with the permit application.

MR. APPEL: And he signed his name which appears at the top of it.

MR. LAURISKI: And I think the question is appropriate. We've only had one basic question, two questions with respect to the permit application that he signed, Exhibit A, and that he's familiar with baseline data. So that's where we're gonna hold the line on cross-examination.

MR. MITCHELL: Let's determine if there's a question pending still.

MR. LAURISKI: Mr. Smith, would you reask your question.

BY MR. SMITH:

Q. My question is, is this the same probable hydrologic consequence that was used to get the permit originally, that has just been modified for the substantial revision, or is this an entirely different document than the PHC?

A. I don't know. That I don't know.

Q. Does it contain information that's -- for example, does it contain information -- is this solely directed towards the -- is everything in here solely directed towards and only relevant to the revision that's sought by Co-op?

MR. MITCHELL: Answer yes or no.

THE WITNESS: Okay.

MR. MITCHELL: Or I don't know.

MR. LAURISKI: Mr. Mitchell.

MR. MITCHELL: Sorry.

MR. LAURISKI: You know, your witnesses need to be prepared ahead of time in terms of how they answer, and let him answer the question so we can move on because all it's going to do is create more objections and we need to move on.

THE WITNESS: I don't believe the question is one that I can answer the way it's stated. Okay? I guess I cannot answer the way it's stated. Perhaps restating it would help.

BY MR. SMITH:

Q. Let me try. Is all this data in Exhibit C, is this all directed solely towards the revision or does it contain data for the previous permit?

A. Okay. I think I understand. This contains, this information was submitted I believe for the significant revision.

Q. So, all of the things that are in here would be relevant to the issuance of the approval of the significant revision?

MR. HANSEN: Objection, calls for speculation.

MR. LAURISKI: Objection overruled. You can answer the question, Mr. Haddock.

THE WITNESS: I would say this is relevant to the approval of the Tank Seam revision, yes.

Q. Okay. And so the information in here that discusses dewatering in the Blind Canyon Seam, that was relevant towards the determination to grant the significant revision of the Tank Canyon Seam?

A. I would not say that.

Q. Well, what is it relevant to?

A. I'm not sure. What was your question again?

Q. I'll withdraw that question.

What is the purpose of the document that's Exhibit C, Probable Hydrologic Consequences?

A. That is a document that was submitted by the applicant which discusses what the -- essentially what the probable hydrologic consequences of their application is going to be, what consequences their operations would have on the hydrologic balances of the area.

Q. And to do that, would you need to have baseline data in this document to determine -- would that be considered a necessary part of the PHC?

A. I think baseline data is a necessary part of any application.

Q. Can you direct me to the baseline data in this Exhibit C?

A. No.

Q. Regarding only the flows from Birch Spring and Bear Canyon Spring?

A. I don't believe I'm qualified to do that.

Q. Well, before, you testified that there could be a limitation on the baseline data in this document; didn't you testify to that effect?

A. I don't recall saying that.

Q. So, you're not qualified to say what should be in this document?

A. I believe I know what should be in this. What I'm saying is, I don't -- I have to rely on other people to review this, and so, you know, I'm not completely aware of where everything is located in this. And I believe that was your question.

Q. And you can't direct me to where the baseline data is regarding the flows of Birch and Big Bear Springs in this document?

A. No.

Q. Is it your understanding that those -- that information needs to be in this document?

MR. LAURISKI: Mr. Smith, I think he already said yes, it was his understanding.

MR. SMITH: I don't have any other questions.

BY MR. APPEL:

Q. Is it safe to say, Mr. Haddock, that you relied upon Mr. Munson's recommendation before you signed this particular document?

A. Yes, it is.

Q. So you didn't read it in depth?

A. That's correct.

Q. Okay. Thank you. That's all I have.

MR. LAURISKI: Thank you. Anything further?

MR. MITCHELL: Nothing.

MR. LAURISKI: Mr. Hansen?

MR. HANSEN: No.

MR. LAURISKI: Thank you, Mr. Haddock.

MR. LAURISKI: Mr. Mitchell, anything further?

MR. MITCHELL: No.

MR. HANSEN: Mr. Chairman, petitioners have tried to set up a straw man for purposes of knocking it down. I would like to call Charles Reynolds as rebuttal.

MR. SMITH: We object to that Chairman, we have called our witnesses, called no rebuttal witnesses. The only proper witnesses they could call would be surrebuttal to our rebuttal. If they wanted to call Mr. Reynolds -- I'm sorry, Mr. Chairman.

MR. LAURISKI: Thank you.

MR. SMITH: I think they've had two bites of the apple, and a third bite, especially at this late hour. It's not called for and highly improper and we strenuously object to that.

MR. HANSEN: Petitioners have made a lot of noise about where in the application is this baseline data, and that's the only issue I want to get into. It was something that they got into and exceeded the scope of direct examination, and I think it's fair to have, and point out to the Board where that information is. Like I say, it will only take two minutes.

MR. APPEL: But the response may take quite a bit longer if he has Mr. Reynolds justifying the baseline data in these documents.

MR. HANSEN: I have no strong feeling on it either way. Mr. Haddock testified the information was in the application, and he just wasn't able to testify where it would be, if it was in Exhibit C. The evidence is in and it's in the application.

MR. LAURISKI: You have had two opportunities to put Mr. Reynolds on the stand. You have an opportunity in your closing arguments as well as in your post hearing memorandum, to clarify or point out any issues that are necessary along that line, so I'll not allow Mr. Reynolds to come back.

MR. HANSEN: I understand.

MR. LAURISKI: As rebuttal.

Okay. Again, with that, hopefully we can move to closing arguments. Given the fact we're going to allow you to file post hearing memoranda, I expect these arguments to be brief and to the point and without interruption. Thank you.

Mr. Hansen?

MR. HANSEN: In light of the fact we will be filing written arguments, my closing argument here will be very short. We need to focus on the narrow issue and we have heard the petitioners, I think, bleed all over the record and go very far afield of what the issue really is. Regulation R645-300-133.400, requires the Division to determine that the proposed operation has been designed to prevent material damage to the hydrological balance outside the permit area. And the Division has made that determination. And the only real issue is whether that determination is supported by the facts, and in particular, the issue is whether allowing Co-op to mine the Tank Seam, will cause material damage to Birch and Big Bear Springs. That's the issue.

The issue is not what happened three years ago in Big Bear, or in the other mining operation. There will be no material damage as the Division has already found, because first, there is no water at the Tank Seam, there is no water above the Tank Seam, there is no water below it.

Second. There is no significant risk of contamination. Whatever contamination might conceivably arise, and petitioners have identified no source of contamination, would likely be no different from what any other risk might already exist in the present mining activities, and that's already been resolved in favor of Co-op Mine. That type of contamination does not pose a significant risk. The only possible sources of contamination are from typical mining activities that arise in any mining activity. If that was a concern, every mine in the state would have to be shut down.

Third. The uncontroverted evidence establishes that

Big Bear Spring is hydrologically isolated from the permit area, and it also establishes that the Birch Spring is hydrologically isolated from the permit area. There is a great deal of testimony to the contrary primarily from Mr. Montgomery. I'm not going to go into any details there, but I'll demonstrate through my written argument that his testimony is inconsistent, and does not support the conclusions that he would like the Board to come to. And I'll leave it at that.

MR. LAURISKI: Thank you.

MR. MITCHELL: I'll reserve it for writing.

MR. LAURISKI: Thank you, Mr. Mitchell.

MR. SMITH: Well, I never reserve anything to writing when I can say it. So, I first want to tell the Board that I've appreciated your patience. I bet if you thought you were gonna sign on for hearings like these, you would have thought twice before you signed on to the Board. And it's been a long day and-a-half for the Board, and you've been extremely courteous to us, and we understand that we're, you know, coming here with a difficult issue. And it's difficult for us and we think it's difficult to everyone because it's such a critical issue. Safe drinking water and having drinking water is second only to air, and having air to breathe is important to the people.

And I think you had a chance the first day to see our clients who were here representing, and trying to do a good job representing. You see these are modest companies that serve modest folks in an area of the state that is, you know, where you work for a living. And we understand that Co-op Mine folks do the same. And we understand we have a difficult issue.

We also understand the very great importance of this Board. First, we have -- there's a wisdom of how our state is set up by the regulatory system for mines. There's kind of a double fail safe; the first front line is the protecting of the public and the public's water and the drinking water, is the Division itself. And that we think they do a good job, and unfortunately we think in this instance, maybe not as good a job as they needed to do.

And I think there was a recognition that there wouldn't always be, just like anything else, the Division isn't perfect just like anything else. There may be instances where something else needed to happen or some -- a second look, and that's where this Board is. This Board is the expert citizen Board, however you want to put it, that is here to review, carefully review, we hope, the things the Division does because the public is depending on this Board to do that review,